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LIFE ON THE WEST COAST OF AFRICA.

By an Officer of the West India Regiment.

MONOTONY of barrack life may be said to reach its climax at Sierra Leone, West Africa. Here there are none of the ordinary amusements of a foreign station, such as gymkhanas, polo matches, dances (except dignity balls, with the ladies of color) to brush away the barrack yard cobwebs from the weary subaltern's eyes. However, each officer has to put in a year's service on the coast before he is entitled to his leave, so he sets to work to make himself as comfortable as possible, and to get as much fun out of the place as he can. One takes to photography, another to collecting butterflies (and right well are his labors repaid, for there is no better place in the world for the entomologist than Sierra Leone). Sometimes the naturalist and collector comes out so strong in the subaltern that he will walk these regions for miles with a butterfly net and attendant "boy." It is interesting to note the function this "boy" plays in the economy of butterfly collecting. I have invariably noticed that the entertainment eventually takes the form of the subaltern sitting in a shady spot near the luncheon basket, while the "boy" gathers the flies. Then, again, a four can always be got together for lawn tennis in the cool of the evening; then there are bachelors' picnics on Sundays some seven miles out from Sierra Leone, where cold chickens, potted meats, and lager beer are consumed under the grateful shadow of lofty rocks with the cooling waterfall splashing at your feet. Afterward the pipe and inevitable sleep. Sierra Leone is a most picturesque place as viewed from the harbor; the town, with its white houses gradually sloping up to Tower Hill Barracks, where the West India regiment is stationed, the lofty mountains in the distance covered with dense vegetation form a most pleasing picture, especially from the stern of the ship when you are homeward bound, as a friend of mine remarked.

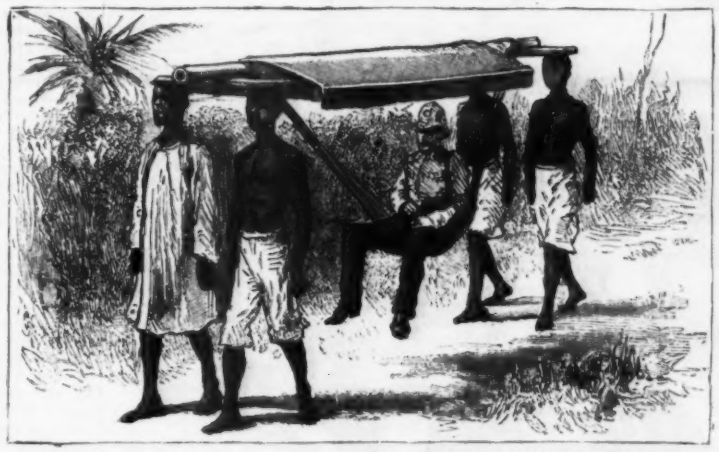
The colony of Sierra Leone or Lion's Back (called from the shape of the mountains) was originally discovered and named by the Portuguese in the fifteenth century. They were driven out by the Dutch, after whom came the French; it was used by all these nations as a depot for slaves, and an old slave tower, now used for a reservoir, may be seen at Tower Hill barracks. For the next two hundred years the town was periodically ransacked and burned by English pirates. A free colony was established by the English in 1787, consisting of a few hundred freed slaves and a few whites. Freetown was built in 1791, the colony being now in the hands of a company. It was surrendered to the crown in 1808.

From November to April the weather is all that can be desired—bright, sunny days, with cloudless, blue sky and clear, moonlight nights; and in January comes the harmatan (a cool, drying wind from across the Sahara), drying up everything, cracking the furniture and filling your tent with dust; but it is cool, and that is something. The tornadoes are the heralds of the rainy season. They come on very suddenly, and last two or three hours, being accompanied with a strong wind, tremendous peals of thunder, and vivid lightning. And woe betide your quarters if the jahnsies happen to be left open. The rains come down in May, and last until October; then farewell to all excursions, for a wet skin is the usual result of wandering too far from home during the rainy season—and rain it does then, sixty-two inches of rain being registered in one month.

The shooting is very indifferent, and accompanied with much weariness of the flesh; to tramp for miles up and down hill over heavy ground and through dense bush, with creepers coiling round your neck and threatening to strangle you every minute, in a damp and exhausting climate, to return home after four hours of this with an empty bag, generally damps the keenest of sportsmen after a very few trials. Bushfowl, a kind of partridge, is the only game to be found, and these are very few and far between. No one seems yet to have discovered why horses will not thrive in Sierra Leone; but there the fact remains. Over and over again they have been tried, but only to die; of course, there are a few exceptions. Whether it is the want of good fodder or the malarial influence of the climate, no one seems to know.

In Sierra Leone there were in the whole district just about three ponies—I don't think I exaggerate, but there may only have been two. We subalterns used to look upon them with covetous eyes. One morning, when we were encamped on the heights, hearing a wild shouting and whooping, we rushed out of our tents, only to behold a Mandingo native riding a long-tailed horse into camp, thrashing him at a gallop through the entanglements of tent ropes, regardless of all expense. The steed was eventually pulled up, and the long-robed rider rolled off and offered his mount for sale. A greater sensation could not have been aroused by the appearance of the lord mayor in gala dress. Every subaltern with anything like an equestrian reputation then put on his most "horsey" air, and examined the prize with much wisdom and pursing of lip. The most practical "sub" mounted and tried him at a fence, but returned with a poor opinion of the leaping capacity of West African thoroughbreds; and it *was* a thoroughbred—the man said so himself. Whether it were lineally descended from Mahomet, or he was only calling Mahomet to witness, it was difficult to say; but we gathered that it was incontestably quite thoroughbred. Horses, as a matter of fact, are most plentiful on the healthy uplands of the interior; but in the deadly forest strip along the coast (which seems to be the only part of the country we care to have) the poor brutes cannot live.

The official and recognized and most comfortable means of locomotion is the "hammock"—simply a hammock slung on



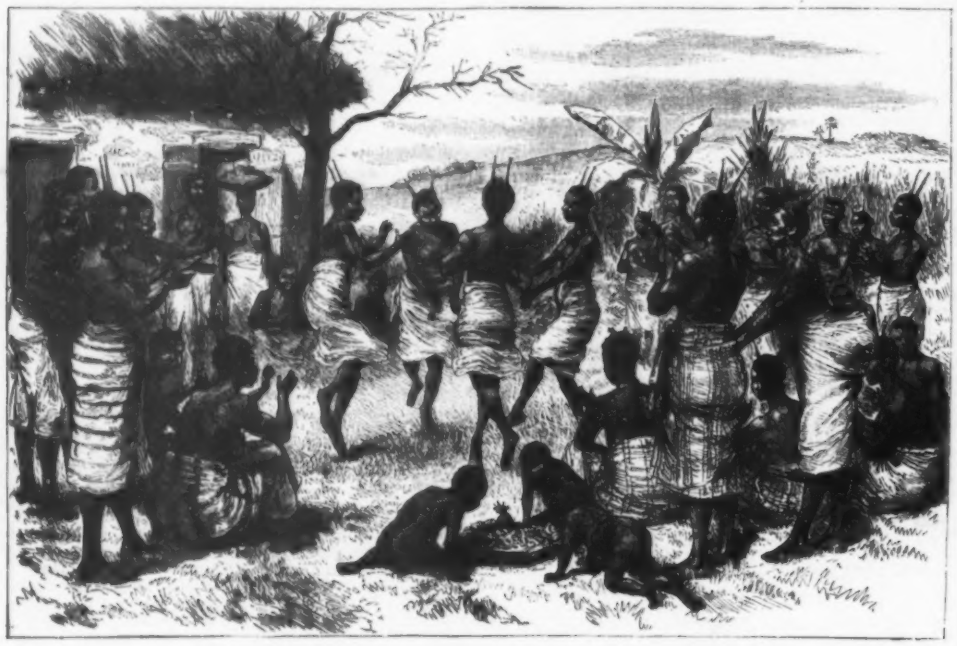
THE OFFICIAL MEANS OF LOCOMOTION IS THE HAMMOCK.

CARRYING A CHIEF TO A PALAVER.

THE SECOND WEST INDIA REGIMENT EMBARKING FOR SIERRA LEONE IN A SURF BOAT.

a pole and covered with an awning and carried by four bearers. It looks a very heavy burden for four men to carry for miles; but I once, on getting out to stretch my cramped limbs, made the head "boy" get in, which he did with much giggling and laughing, and I took his place for a few hundred yards, and was surprised to find how easy the burden was and how little one felt the weight on the head. I should like to have tried a mile of it, but the hammock "boys" were threatened with hysterical convulsions, and I had to give in. They have such a ludicrously keen sense of humor, have hammock boys.

On the west coast there is seen, besides the hammock, as a means of locomotion for Europeans travel-



A NATIVE GIRLS' DANCE, SIERRA LEONE.

ing, an adaptation of the *jinrikshaw*. It is a most comfortable means of conveyance.

The natives seem always to be dancing—all night long at Sierra Leone there comes floating up to the heights from the flats below the muffled distant throbbing of drums and beat of "clackers" telling of the women dancing.

A thousand miles down the coast is Cape Coast Castle, which, until quite recently, was a military station and occupied by a detachment of the West India regiment. Cape Coast Castle, it will be remembered, was the base of operations in the Ashantee war; the castle is a fine old building, erected by the Dutch or possibly Portuguese. The walls are very thick, and evidently show that labor was cheap in those days. Under the court-yard within the castle walls lie buried the remains of the poetess, L. E. L., who died in 1838, her husband being the governor of the colony at that time. The castle must have been strongly fortified for those times, and fully capable of resisting the invasions of pirates, as the old guns have a good command of the only practical landing place; heavy surfs are frequent all down the coast and make the landing very dangerous. The native crews are very skillful with their paddles, and manage to get through somehow; but many lives have been lost by the capsizing of the boats.

The town is a very quaint-looking place, principally composed of mud huts with flat roofs, interspersed with a few strongly built old Dutch houses—the mud or "suish" houses frequently come down with a run when there is an extra downpour of rain; then, in the most philosophical manner, out come the family of three or four generations and proceed to build it up again, each according to his own idea of architecture—the aged grandfather and the toddling infant each lending a hand. The natives here are Fantis and Haussas. Civilization has not made such strides here as in Sierra Leone in the way of tall hats and black coats, but still the native, who all the week is clad in the simple country cloth and walks about barefooted, thinks it indicative of respectability to don European clothes and boots on Sunday and with a tin-mounted stick and green tassel to promenade the streets; but he does not somehow seem altogether at home, and with Shakespeare might exclaim, "Uneasy lies the head that wears a crown," or a hat.

The imperial troops were withdrawn from Cape Coast Castle a short time since, and the station is now garrisoned by the Haussas, a native force under the Colonial Government and officered by Europeans.

Palavers are very frequent in Cape Coast. The chiefs come down arrayed in all their glory, with the inevitable umbrella held over them by a slave. The umbrella is a very gaudy affair, all the colors of the rainbow, and is more a badge of rank than a protection to the swarthy features of the chief. Each chief is accompanied by his band of tom-toms and reeds. Out of these instruments no apparent tune is produced, but a deafening din rather like the noise of some of Haydn's demons. Trade gin is in great request at these palavers.

Sierra Leone has one crow over Cape Coast, for whereas the one has three horses, the other can only boast of one—one solitary, hopeless, lonely, lank "gee." Poor solitary beast! The neighings of his fellows, the frolics and racketings and horseplay of his own kind unknown to his stunted intellect—only to munch the repulsive grass for a few moons and then to die! Yet he has much food for reflection. He sees kings—kings are as thick as squires in Ireland or princes in Russia; he sees kings come and go and thinks nothing of it. He hears their "tom-tomming" and "tootling," and he wonders, perhaps, why all this royalty, with its barbaric pomp and its white rods and black rods and gold axes and its leaping, whooping attendants, should be so much in awe of a few white men with nothing to back them but a handful of gayly tailored zouaves—these curious white fellows who come from the sea across the swishing surf and land from the surf boats as if creation were specially designed for them. But his intellect there deserts him. Only one fact remains: *he* can see hosts of kings; but may *they* only see one horse.

The religious creeds all down the west coast of Africa are many and varied. A great number belong to the Mahometan faith, including the Haussas. In all the native creeds fetish largely prevails, and no native is safe from the curses of the medicine man, which curse is generally fulfilled, as the unfortunate victim has poison put into his food or drink; but, of course, that is the work of a devil. However, this superstition has a deterrent effect on a good many crimes, especially thieving.—*The Graphic, London.*

BOAT RACING IN BURMA.

MANDALAY has been quite *en fete* for three days during the Viceroy's visit. He was received by a large concourse of people, and the whole of the official staff, civil and military, under a "pandal," or covered shed made of bamboos and paper, with cloth here and there. Upon the paper and cloth were painted some curious and wonderful Burmese devices and figures, which shone out brilliantly in the sun. After this gorgeous reception the Viceroy proceeded to Government House, which is situated on the ramparts at the north end of Fort Dufferin. The north gate of the fort was for the occasion cleverly utilized as a stairway and reception room.

One afternoon was devoted to Burmese water sports and boat racing. Out of six entries four were dead heats, and the excitement was kept up by loud plaudits among the crowd, for the Burmese are keen spectators of all sports. The boats are simply long shells of boards bent up at the ends. Each boat is propelled by thirty-two men as paddlers and a coxswain, as shown.—*Daily Graphic, London.*

VANILLA.*

By CHARLES E. HIRES.

THE importance of vanilla bean, and consequently the value of the subject of which I am about to speak, cannot be more correctly estimated than by a brief glance at its importance and value as a factor in the commercial products of this country.

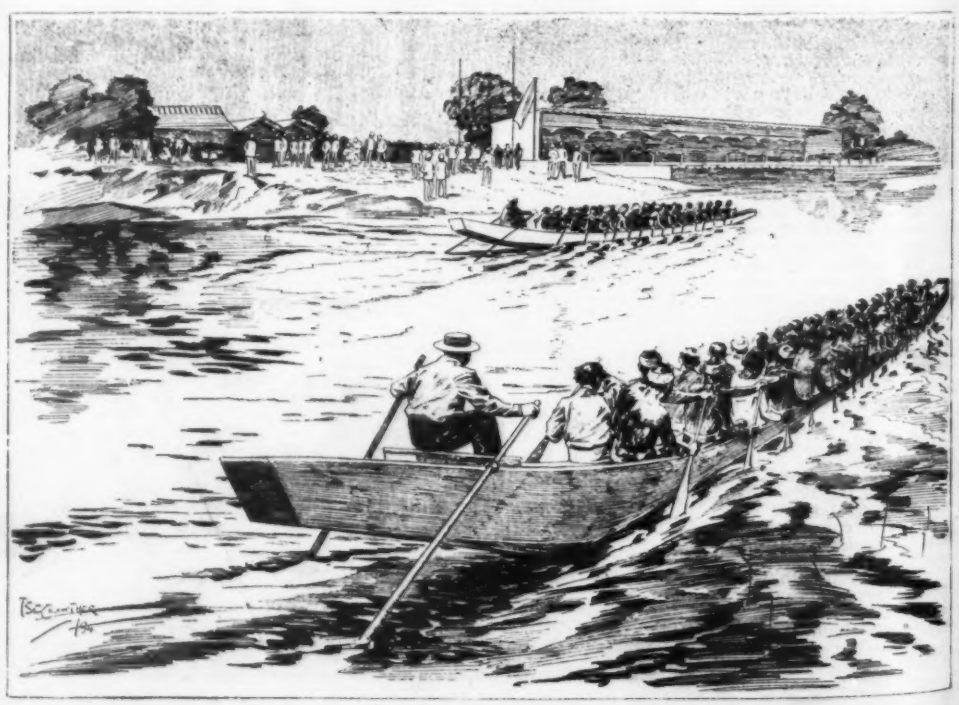
To the majority of men the use of vanilla bean is limited to a flavoring extract for ice cream or to add a delicacy and piquancy to an after-dinner dessert; but to the specialist, familiar with its use, it assumes a magnitude that is really astonishing. In the year 1892 in this country alone there was imported and consumed in the various industries and agencies requiring vanilla over one million dollars' worth of this product, numbering over fifteen million beans, and employing in operations of raising, picking, curing, packing and shipping over 35,000 people, constituting in value, in commercial importance, in capital involved in its production and in the amount of labor required for its development, one of the most important products of this vast and rich country.

The vanilla bean is indigenous to the soil of Mexico. The chief center of its cultivation is the state of Vera Cruz, and the metropolis of the vanilla district is the city of Papantla. After twenty years of active experience in handling vanilla, after a long and careful study of it as an article of commerce, and an intimate acquaintance of its various uses, and its growing value as an article of import, I became possessed with a desire to see it in its natural state, to ride beneath the forests where it grew, to pluck it by my own hands from its natural branch; to enjoy its sweet and delicious aroma in the land of its birth, and in general to familiarize myself with the growth and preparation of this wonderful product, which is so rapidly growing in favor as one of our 19th century luxuries.

Take down your map of Mexico and locate the city of Vera Cruz, in the state of Vera Cruz, situated on the western shore of the Bay of Campeche. Go north from Vera Cruz a distance of some three hundred miles to Tuxpan. Equip yourself there with a retinue of mustangs, servants, guide and interpreter, and start to the southwest on a three days' journey, over mountains, through impenetrable forests, over dangerous and treacherous morasses, and through tropical jungles to the city of Papantla, situated about seventy-five miles from the coast, inaccessible by railroad or water, and in the heart of a wild and as lawless a country as you would care to visit, and you have reached the heart of the vanilla growing district; only a few hundred miles by actual measurement, but requiring more time, toil, privation and danger than to make a trip to the Orient. The journey southward was one to me of absorbing interest and constant danger. Its strange inhabitants, its peculiar customs, its striking scenery, and its topographical and geographical features were so impressed upon me by my journey, that I know my audience will pardon a brief and hurried description of some of its most salient features as we pass on our southern march to the home of the vanilla bean.

Actuated by the desire before mentioned, I left Philadelphia on January 31, 1893, on a bright, clear, cool but pleasant Monday. Next day in the State of Indiana we struck a blizzard, with the thermometer down to zero; reaching St. Louis, we encountered the worst snow storm of the season, with the thermometer below zero, and the cars impossible to keep warm. Leaving St. Louis at eight o'clock in the evening, we journeyed southward and the next morning found ourselves with the thermometer 55° above zero, with a bright sun and no signs of the storm we had passed through but a few hours before. On, on we fly into Texas with the thermometer going higher the further we proceed. At Austin it was 70°, and our heavy underclothing felt a little uncomfortable. At Laredo we came to the

* Read at a pharmaceutical meeting of the Philadelphia College of Pharmacy, Nov. 21.—*From the American Journal of Pharmacy.*



A NATIVE BURMESE BOAT RACE AT MANDALAY.—FROM AN INSTANTANEOUS PHOTOGRAPH.

border of the United States and Mexico, with a feeling that at last we were in Mexico.

From Laredo on the Rio Grande to the city of Monterey it is a distance of 170 miles. After a run of a few hours we stopped in a little town—Salinas. We found ourselves here confronting a civilization entirely different from that which we had left; here were one-story huts, thatched roof, a door, but no windows, women and children at the door, and the children half naked. No floor but that of hard dirt, no furniture but a chair and stand with a lamp; a bundle of clothes in one corner, probably used as a bed. Flowers were in bloom, a species of cactus six feet high was growing everywhere, and the Spanish bayonet, a queer-shaped tree of the yucca variety, was the one prominent tree in the landscape. My vanilla expedition has now carried me about 2,200 miles from Philadelphia into new and strange surroundings. Let us stop for a moment in the investigation of a scene of interest.

We find here a singular and instructive commentary upon the silver question that is now agitating the country. I found in spending money that this is one of the best countries in the world for this purpose—the more money I spent the more I had left, owing to the very low price of silver, and Mexican finances being based on silver values. The Mexican dollar (or peso) is worth 65 cents and an American dollar is worth $1.60. When I bought $1.50 worth of goods, and gave a $5 note I received $6.25 in change, and it struck me as one of the most wonderful things in political economy that I had ever seen.

My next stop was in San Luis Potosi, 300 miles from Monterey. It has a population of 60,000. On the way you cross the Tropic of Cancer and pass from the temperate to the torrid zone. Here we come to fields and fields of the green century plant.

I next visited Toluca, some 300 miles south of San Luis Potosi and 45 miles north of the city of Mexico, the capital of the government, where I spent nine days.

Leaving the city of Mexico I proceeded to Pueblo, then to Jalapa, and on to Vera Cruz, taking the Ward's line of steamers up the coast to Tuxpan, where I arrived after a thirty hours' sail. Here a tug came to the mouth of the Tuxpan River and took me off, steaming up the river nine miles to the city of Tuxpan. The city has 10,000 inhabitants, and is composed principally of one-story, limestone, thatched houses. After spending three or four days here getting my outfit together, consisting of four mustangs, servants, guide and interpreter, we started early on Monday morning for the vanilla land.

Hastening on, we rode through a dense forest by a bridle path, where we had to go single file, which brought us to an Indian village on the Casonies River, after some thirty miles of hard riding, besides having to ford several rivers. I would state here that the sun is intensely hot at midday, so that the most of the people retire from about 11 to 2 o'clock. We stopped about 11 o'clock, at a small village composed of bamboo and thatched houses, where we waited until 4 o'clock before proceeding on our journey, and arriving at Casonies in the evening at about twilight. On the Casonies River we saw hundreds of Indian canoes plying up and down this stream with both men and women propelling them, which was a curious sight. We started early next morning for Papantla, where we arrived at about nine o'clock at night. This is some thirty-five miles further inland. It is a city of about 12,000 inhabitants, and is composed mostly of one-story limestone thatched houses. This is the metropolis of the vanilla growing district, situated in the valley surrounded by high mountains on all sides. This is the county seat. Court was in session when we arrived there, and it was impossible to get accommodations at the one hotel or any of the boarding houses. The hotel is a one-story building, composed of three or four rooms; these were all turned into sleeping rooms at night, and everybody had to sleep together—men and women; cots were arranged side by side, until there was scarcely room to get around. As the climate here is always warm, eating is done mostly out of doors. By the courtesy extended to me through letters of introduction I had, I was taken and well cared for by Mr. Tremari, who is one of the first citizens and the largest curer and shipper of vanillas in Papantla.

At last, after countless difficulties and strange experiences, I am at the goal of my journey—in the land of vanillas, in the center of a district from which a large portion of the world's supply of this luxury is derived, and in readiness to transform into a reality the dream of years; and from here I ask you to pause with me a moment to scan briefly the history of this strange and popular product, of which little is known to the general student.

When the Spaniards discovered America, the custom among the Aztecs of flavoring chocolate with vanilla was already in vogue. The former borrowed the practice from the latter and transmitted it in turn to the other nations of Europe. A few years later this valuable product became an export article, and it is believed that the first vanilla bean introduced into Spain came from the state of Oaxaca. It is raised in divers parts of the continent, in the Island of Cuba and other Antilles, and in some portions of Africa and Asia as well, and as a rule wherever there is heat and moisture and shade, provided the lowest temperature in winter be not lower than 65° F.

At first that which grew wild in the woods was harvested, and the inference is clear that, in proportion to its gradual diminution and increasing consumption, it was found necessary to foster its growth, and in this the state of Vera Cruz took the initiative, being the first place known in which the plant is under cultivation in America. Notwithstanding numerous inquiries made by me, I have found it well-nigh impossible, even with the aid of tradition, to ascertain the exact time in which the cultivation began; this alone being known, that the period is a remote one. From some of the old archives of Papantla we derive the information that in the year 1760 there were already in existence vanilla forests under cultivation. The state of Vera Cruz has had and to-day possesses great natural advantage for the production of vanilla. But it is cultivated only in the cantons of Misantla and Papantla. For a number of years Mexico supplied the markets of the world with this product, but of late years the islands of Bourbon and Java have come in competition with European markets to a marked degree.

With this brief history of the origin and nature of vanilla, start out with me on a bright, clear morning in the month of February, with the thermometer ranging from 85° to 100°; dressed in thin linen, with a light Panama hat, and mounted upon a mustang for our first visit to the vanilla fields, located about nine miles from Papantla. The first error that you need to correct is our northern conceptions of a field. It is not here the carefully tilled, snugly fenced, and finely cultivated tract of land that characterizes the marketable products of New Jersey or Pennsylvania, but a wild, boundless, dense and almost impenetrable forest, with undergrowth so dense and rank that our mustangs must be abandoned at a by-path, and we ourselves compelled to stoop almost to a creeping posture to penetrate it. Look at yonder tree—a Mexican cedar—20 feet in height, covered with dark green luxuriant verdure, with a small tapering trunk, a few feet in circumference, and clinging to and apparently growing out of its bark observe that strange looking, clinging vine, in circumference a little larger than an ordinary lead pencil, shooting up into the tree, covering its branches, and running from it into the adjoining trees, and often forming festoons and arbors so dense and thick as to exclude the rays of the sun at noonday. Covered with a dark green and spear shaped leaf, and hanging pendent from its interlacing branches, green pods, from four to ten inches long, and you have a picture of a vanilla vine as I first saw it in its native soil and in its highest state of cultivation. Tree after tree in this vast forest is covered with those luxuriant vines, peeping from which, in all the glory of tropical luxuriance, are countless hundreds of the long, luscious, tapering vanilla bean; in circumference almost equal to a banana and from two to three inches longer. Some of a dark green and others of a bright yellow, and sometimes where they grow most luxuriantly resembling bunches of bananas, apparently growing upon the native trees of the forests. The remoteness from civilization, the total absence of everything indicating care or cultivation, and the strange juxtaposition of this wealth of ripened fruit to the wild and unbounded woods made the scene one of the most strange and marvelous upon which the eye ever rested. Vast areas containing hundreds of square miles of contiguous territory in this province are devoted to the growth of this plant; wherever you look and wherever you travel you are confronted with this overhanging vegetation. You behold the primeval forest utilized by the half civilized natives as a natural garden for the growth of this delicious aromatic plant.

The cultivation of the plant consists of cutting away the forests to give it room to grow. The vines are naturally grown from cuttings, the same as grapevines, but they are also grown direct from the seeds, and in such cases the fruit is much later than when the vines are planted. The vine is very hardy in its native element, and sometimes takes root even if thrown carelessly on the ground, provided it has shade and moisture. Four or five years after the vine is planted, and sometimes before that period, its base rots at some distance, and before this occurs rootlets form above that portion which is dying, and have already grown and descended along the tree to get nourishment from the earth. This circumstance, added to the fact that if a reed be severed some distance from the ground it does not die, has given rise to two distinct theories respecting this plant, which I desire here to take the opportunity of correcting; the first theory, which has the support of many reputable scientists, is that the plant is epiphyte, deriving its sustenance from the atmosphere, and being independent of the soil, and the second that it is a parasite and derives its nourishment chiefly from the trees to which it clings. A careful examination of the plant in its natural forests and a patient study of its habits and characteristics have convinced me that both of these theories are founded in error, although, before my visit to Mexico, I confess I had been led to adopt the parasitic theory upon information from many intelligent growers.

Mr. Fuenti told me he had made the experiment of severing the reed two or three feet from the ground, and in a few days later two or more tendrils had sprung from the lower end of the vine and gone directly to the earth, thus replacing the lost base. The reed is very juicy, and when deprived of its roots tries to replace them, complying with the laws of its own existence: but this is done at its own expense, taking nothing from the tree, which statement is proved by the fact that if it consumes too much time in its endeavor to reach the soil it withers.

Should the tendrils reach the soil before the reed is entirely dried up, the latter recovers later; but if, on the contrary, its strength is not sufficient to accomplish the task of reaching the earth, it gradually withers until it does. In spite of the facility with which the reed takes root and replaces its base, some die, either because the reed was not fresh and sound or because it was damaged, or by reason of its being in localities where it received too much sun or too much shade.

I found others familiar with the vanilla growth contending that the plant depended for its nourishment and growth upon the sap of a particular tree—the cojondigate—and in support of this theory I was taken to the forest and shown vines growing luxuriantly around the base of this tree, showing great fertility and productiveness and a high state of health. But upon examination of the facts I found that this tree would grow only upon certain soil and under certain conditions, where the soil was always moist, and the reason that the vanilla grew so much better on this than on any other was because the conditions that so well suited the tree were the very conditions that best suited the vanilla plant, and when speaking of my observations in this direction, they admitted that it might be possible, and when finding in one of the gardens of Papantla a vine growing upon a dead tree, they could not but confess that it was perhaps not a parasite.

These good people had proved to me, or assured me, in their correspondence that the plant was a parasite, and it gives me pleasure to correct the error I was then laboring under.

After making diligent inquiry about the plant I had the pleasure of meeting Agopito Fontecilla, who I soon learned was an intelligent man, and who had made a scientific study of the plant, and to whom I am indebted for the greater part of my knowledge of the plant.

Taking the average of the last ten years, the number of beans that has been gathered each crop has been above 15,000,000, with the exception of a small quantity gathered on the southern coast of Vera Cruz, some 100,000. The remainder comes from the cantons of Papantla and Misantla, mostly from Papantla. The prices which it has attained during that time have varied much, ranging from $22 to $125 a thousand. According to the data in my possession it averages $60 to $70, and produces over $1,000,000.

The smallest unripe vanilla weighs 20 pounds to the thousand, and the largest 65 pounds to the thousand, and the average about 45 to 40 pounds. The average loss of weight in curing is about 9 pounds to the thousand. The length of the bean varies as much as its weight, measuring from 4½ to 10 inches; the greater part ranging from 7 to 8½ inches. The plant (Vanilla planifolia) grows a few yards in length each year, some portions of it clinging to the tree which supports it, and some remaining loose and hanging wave-like. Its thickness is about ⅜ to ½ inch. It is very juicy, round and of a green color, knotty at intervals; leaves alternate, shaped like spear and plump. The flower is yellow and has a sweet, agreeable smell. The plant grows in length only. It does not grow anything like a grapevine; it only bears fruit upon the new portion that grows each year. The thickness of the vanilla bean decreases gradually from two-thirds of the lower portion to the tip. Its shape is almost round, somewhat flattened on one side, curving up to the neck, which generally terminates in an arc. Its circumference varies, measuring when green from two to three inches, although the greater part measures three-fourths of an inch in diameter. It has a thin, smooth cuticle, with two superficial lines on either side. When thoroughly ripe its color varies from dark green to light yellow. Its lower portion is filled with small seeds, and after being treated its thickness is reduced to one-fourth of its original size. It remains black, oily and has an agreeable perfume.

Around Misantla there are often several varieties; these are known as Misantla bean, having thick skins. They are not packed as well, and are not considered as valuable as the Papantla curing. These varieties are designated by the natives as cimarrona, mestiza, manza. When cured only an expert can tell the different goods. The wild or pompoma bean, segne xante, or sometimes called banana vanilla by the Totonaca Indians, who eat them, is to be found here. This plant differs from that of the Vanilla planifolia in that it is much smaller, with larger leaves and less pointed. The bean is about twice as thick and of a triangular shape, somewhat resembling the ordinary banana when insufficiently nourished. It has an agreeable fragrance, resembling that of the anise plant. It is commonly and naturally supposed the beans grow and thicken until approaching ripeness. It is not so, for after it is two months and a half old it ceases to increase in size. Mr. Tremari said he had made several observations during the past two years, measuring vanilla from different vines, and has found that some after the middle and some after the last half of June have neither grown nor thickened in the least.

The vine puts forth many blossoms, but the greater part do not bear, and those attaining full growth fall, or turn yellow and crack prematurely, owing to some disease in the reed; the bean, however, clings to it. This serves as a pretext for some persons to say that in October and November the vanilla bean is ripe and should be cut, not bearing in mind that its apparent ripeness arises from sickness in the plant, as shown by its defective nutrition, being soft to the touch and lacking the solidity of the ripe bean.

I found that the plants grew best in virgin soil where streams and brooks abound, and where the earth is a little sandy, and the dampness is retained longer than in any other soil; in these places the vines grow luxuriantly and vigorously, and yield large fruit, a most important factor, when one considers how scarce rain is in this section between February and July. Marshy ground is likewise undesirable, as an excess of moisture rots the vine. It is found that plants do best where a little sunlight can reach them, and the largest growers have trimmed out the heavy foliage that covers many plants. Yet vines exposed too much to the sun yield little vanilla, and what they do yield is small; the plants soon get yellow and die in a few years. On the other hand, those with heavy foliage never thicken. Their color remains a rich green, and finally sickens. The bean they yield is likewise small, badly nourished, and ripeness is retarded. After setting out the vines, if they do well, they will commence to bear fruit in about three or four years; its yield increases for four or five years, when it begins to decrease. It bears little vanilla after the tenth year. These vines yield when fully developed 85 and some as high as 200, although these are very rare. Some vines have branches that bear as much as 12 to 15 beans.

The proper time for the Mexican vanilla bean to ripen is in January or February, but such a demand is made for the bean that for several years the growers begin to gather the crop in October and November, so that the harvest is over before the time it should have commenced, and this vanilla weighs one pound less to the thousand, and remains red and subject to changes.

Vanilla, if allowed to ripen naturally, remains black, juicy, and of a silvery hue shortly after its curing, and for many years it can be preserved unchanged, but if cut prematurely it is affected much as any other fruit naturally is when picked two or three months before the time, and it never looks as it should when this is done. In order to impart to the bean all the good properties of which it is susceptible it should be cut as it becomes yellow, for, if it be cut all at once, even though it be in the month of January (as was the practice some years ago), the result will be that a great portion of it will remain unripe, because as it blooms in March, April, or May, this same gradual change continues, everything being equal, until it ripens. There is, besides, another cause which brings about the same difference even in the case where they blossom together, and that is the greater or less shade afforded by the trees on which the vines grow. In former times, in compliance with an order from the government, the sub-delegates, and after them the civil authorities, were instructed to see that the unripe fruit should not be cut. When this duty fell to the lot of conscientious and active persons abuses were in a great measure avoided, but complete, satisfactory results were far from being attained on account of the scarcity of the necessary means to watch and pursue smugglers. At

other times the office was applied for by indolent persons, who regarded the orders of the government with indifference, and thus the law soon fell into disrepute, and was finally abolished by the government. The difference between the price of the vanilla picked during October and November and that picked after January is in the proportion of three to nine. Those acquainted with this fact, seeing those beans sell for the third what they know by their yearly experience could be sold for nine, because they do not want to wait two or three additional months, might think them foolish, or would imagine that poverty compelled them to suffer this loss; but it is neither the one thing nor the other, because these people are clear headed and their prosperity so general that it may be said there are no people in the world who live in greater ease than do these people of Papantla, and this is not alone due to the fertility of the soil and the good quality of the products which are obtained by cultivation, but also because in their forests important products grow wild which are the property of any one willing to gather them. The motives actuating these people in selling the vanilla before it is ripe are caused by avarice on the one hand and rascality on the other. The first vanilla sold has, as a rule, been stolen, and as it is cheap, though of poor quality, it is always a bargain for the buyer. The planters who have vanilla beans somewhat distant from their homes, as soon as they know of any purchase or sale, cut their own beans, fearful lest the same may be stolen, as they know by experience that, immediately upon the start of such traffic, complaints are heard from the unfortunates, who in a short time are deprived of the results of hard labor and care. This abnormal condition of affairs goes on, and thefts repeatedly occur even in the best guarded vanilla forests, whose owners cannot constantly oversee by day and by night, as other duties require their attention. For this reason they decide to cut and sell the vanilla bean at very low figures, rather than to suffer total loss. For no other reason is the fruit gathered and sold before it is thoroughly ripe. This unseasonable traffic, both immoral and highly prejudicial to the property interests of these cantons, should be checked by proper legislation; in this way the crop and the quality of the goods would be much greater, and the superior and delicate flavor that justly belongs to the best Mexican vanilla bean would make it esteemed above any other aroma in the world.

In curing vanilla it is an easy matter to impair it either by an excess or lack of dryness. Perfect curing is only attained when the bean is left in such a condition that it remains juicy and retains its greatest possible weight—a consummation which the expert should constantly aim at. If the vanilla is cut when ripe, success will be easy, but when cut prematurely, as has been the case during many years, art has to replace nature as far as possible, which can be done only through labor and substantial knowledge of the subject, so that some idea may be formed of the delicate care needed for this operation. Suffice it to say that even the best known experts sometimes permit the vanilla to dry too much, or else the greater part of it, not to say all, becomes filled with insects, either before or after the process of curing. It is only necessary to allow it to remain in the sun three or four minutes more or less than is required to bring about one or the other of these results. Great care and fine eyesight are required in the separation of the diseased from the sound, because, if only one remains undetected, it will mould and endanger other bundles in a short time. The curers in Papantla excel in curing and bunching the bundles, and in the regularity and evenness with which they classify the size and quality. As a rule, planters do not know how to prepare the bean; so they sell them in an unripe state to curers who yearly employ experts for that purpose. The beans are brought in by the natives in large and small lots, very similar to the way in which our country people bring in rags, butter, and eggs to the town storekeeper. The beans are first put in a sweat box, where they are sweated about 30 hours. They are then placed on mats in the sun if the day is bright and clear, and if not, they are placed in a large oven to dry. This requires the utmost care and attention, else the beans are easily spoiled. After the excess of moisture is dried out, they are again sweated. This operation is repeated until they are black. They are then placed in the sun in the middle of the day only from eleven to one; they are then put in racks in vanilla rooms, one above the other. While the curing is going on it is necessary to separate them with the utmost care; the discolored from the black bundles, the very small, the impoverished, those with skin woody at intervals, the ones with a tough, thick and smooth skin, and also the spotted, cracked or split beans, assorting them in their respective classes. The great care to be exercised in curing vanilla can be appreciated by what I have said before; but it is not amiss to observe that, however little it is over-dried, it is sufficient to reduce the weight almost one pound to the thousand, which would be a great loss; besides, the bean that is over-dried loses some of its color, and depreciates its value $1 or $2 a pound, which amounts to as much as the loss in weight. When the vanilla is thoroughly ripe it is easier to ascertain the required point of curing, and besides gives less trouble and is not so exposed to changes. It gets silvery white being cured, and in a few months it is crystallized, and will be preserved in this way for a number of years. If cut when unripe, just the opposite happens, for not only are few crystallized, but their keeping quality is poor. After the beans are thoroughly cured, which takes from three to four months, they are assorted in different sizes and bundled in bundles containing from 50 to 75 beans each. The different curers have different amounts for their packing. Some 50, some 60, others 70, and some 75 to their bundles. These bundles are all uniform in size according to length, and are placed in cans of 40 bundles each; then four or five of these cans of different sizes are packed in a case made of Mexican red cedar, which is the most plentiful wood grown here. A curer stated to me that the making of these cases was the most expensive part in putting the bean up, as they have no machinery, such as saw mills and planing mills. Everything must be done by hand, which necessarily takes some time to make one of these cases, as the corners of each are grooved and dovetailed together, making the case cost, when completed, from $2 to $3.

After the beans are cased the cases are then covered with a fiber matting made here by the Mexicans, and the beans are ready for shipment. Mules or burros, in some cases mustangs, are drawn up in line and two cases are strapped on the back of each animal, and started for the sea coast in caravans of perhaps eight or ten animals, with two or three attendants; then shipped on steamers for Europe and the United States.

In going from the interior of Mexico you will meet caravans of these beasts of burden laden with all kinds of merchandise, this being the only way of transportation. The authorities for some time have been endeavoring to get a railroad to Papantla, but as yet have been unsuccessful. The Aztecs or native Indians do not want to have any improvements. Several attempts have been made to survey a road, and just before reaching there I was advised of a civil engineer who had been sent to survey a route and who was next day after his arrival found hanging to one of the trees outside of the town. The natives do not want anything different from what they have been used to, and will sacrifice their lives in defense of what they consider their rights.

I returned to America with a conviction that notwithstanding our national character of penetrating to the utmost corners of the earth, as a people we know little or nothing of Mexico, a great, broad, rich, fertile tract of land, magnificently endowed by nature and so favorably located, as respects soil, climate, and physical conditions, that in my judgment it is ere long to become the most prolific source of supplies for many of the essential and valuable products needed by the world; and of her varied and valuable industries, none are more promising and give indications of more important growth than does the vanilla bean. The infusion of greater intelligence in the minds of the natives engaged in its development, the employment of better means for its preservation and cultivation, the opening of newer and larger districts for its supply and a more intimate and scientific knowledge of its natural requisites, would in a few years multiply manifold the volume of this commerce, and would permit it to be placed upon our markets and markets of the world in a far better condition, as respects quality, and at a price that would largely stimulate its use.

I returned to Philadelphia satisfied that my expedition had been of great practical value to me, and that if more merchants and business men, deeply interested in handling and marketing vanillas, could be induced to turn their interest and attention to the conditions and restrictions that surround the production, many of the difficulties and hazards that retard its cultivation, that make its production so precarious, and mar its perfections, and so materially increase the cost of transportation, would in a few years be materially overcome.

I look at the vanilla bean with a new interest. I see in it something of the history of a peculiar people. Its delicate aroma is to me suggestive of the bright blue sky, the blazing sun, the tropical luxury, and the rich atmosphere of the country where it grows, almost the spontaneous child of nature, yet so potential and useful in the varied needs of our complicated life of to-day.

I trust that the brief and hurried view of its habits and peculiarities that I have been able to give you in this brief talk have been of some interest and value from a scientific standpoint and may have tended to render more accurate and definite your botanic knowledge of the vanilla plant, and may have cleared away some of the superstitions and uncertainties that have in the past clouded its history. If so, the object of my talk will have been fully accomplished, and I will have been fully repaid for the little time I have spent in throwing together these somewhat desultory remarks.

A JAPANESE FLOWER SELLER.

NOTHING could better illustrate the differences in appliances and taste between our own street dealers in cut flowers and those of sunny Japan than our cut The light framework of bamboo, with its short lengths of bamboo cut at a node, so as to retain water wherewith to preserve the freshness of the blossoms, grasses, iris stems, and leaves, and the basket-like arrangement of the bottom tier, is as unlike a coster's barrow or the flower girl's flat basket as it is possible to find. Apart from the prettiness of the whole as a street picture, compare the greater security enjoyed by the flowers, carried as the contrivance is by means of a pole resting on the shoulder of the man, to that of being rattled over the stones in a donkey cart to the detriment of everything carried. And what would our street boys be doing with the flowers in the hinder receptacle? They manage these things better in Japan.—*The Gardeners' Chronicle.*

A JAPANESE FLOWER SELLER.

INTERESTING EXPERIMENTS IN GERMINATION.*

By G. J. ROMANES, F.R.S.

THE primary object of these experiments was to ascertain whether the power of germination continues in dry seeds after the greatest possible precautions have been taken to prevent any ordinary processes of respiration for practically any length of time.

The method adopted was to seal various kinds of seeds in vacuum tubes of high exhaustion, and after they had been exposed to the vacuum for a period of fifteen months to remove them from the tubes and sow them in flower pots buried in moist soil. In other cases, after the seeds had been *in vacuo* for a period of three months, they were transferred to sundry other tubes respectively charged with atmospheres of sundry pure gases or vapors (at the pressure of the air at time of sealing); after a further period of twelve months these sundry tubes were broken, and their contents sown as in previous case. In all cases, excepting that of clover, the seeds sown were weighed individually in chemical balances, and seeds of similar weights taken from the same original packets were similarly sown as controls.

The exhaustion of the tubes was kindly undertaken by Mr. Crookes, F.R.S., to whom I must express my best thanks for the assistance he has given. The kinds of seeds used were mustard, red beet, clover, peas, beans, spinach, cress, barley, and radish. In addition to vacuum tubes and control tubes containing air, others were charged with oxygen, hydrogen, nitrogen, carbon monoxide, sulphureted hydrogen, aqueous vapor, ether, and chloroform.

With the exception of the beans, where only two were sown, ten weighed seeds were sown out of each of the tubes, and also out of each of the control packets which had been kept in ordinary air from the first. These results amply prove that neither a vacuum of one-millionth of an atmosphere, nor the atmospheres of any of the gases and vapors named, exercised much, if any, effect on the germinating power of any of these seeds. I may add that the same remark applies to an atmosphere of carbon dioxide, although in the particular series of experiments quoted this gas was accidentally omitted.

A subsidiary object of these experiments was to ascertain whether any appreciable variations would be caused in plants grown from seeds which, before germination, had been submitted to the conditions above explained. Hundreds of plants of the kinds named were grown from the seeds in the various tubes. But

* Lately read before the Royal Society.

in no one instance was there the smallest deviation in any respect from the standard type grown from the corresponding control packet.

In the case of the beet root, a larger number of plants were developed in many of the pots than the ten seeds which had been sown in each. This I found to be due to the fact that beet root seeds very frequently throw up two seedlings apiece. Not so frequently, but still very often, they yield three, and sometimes even four.

Further experiments are in progress.

CHRYSANTHEMUM ROBERT PETFIELD.

CHRYSANTHEMUM Robert Petfield, of which we give an illustration, is one of the most important of the several excellent additions that have been made by Mr. Robert Owen, of Maidenhead, to the incurved section, and promises to attain a high degree of popularity among cultivators of those refined flowers for competitive purposes. The blooms, as so well shown in the accompanying figure, are rather above the average in size, with fine outline and of great depth. The florets are especially broad, stout, very smooth, and finely incurved, the color soft rose, tinted mauve on the back of the florets, the face rich purple. It is unquestionably one of the most finely finished of the incurved chrysanthemums yet introduced, and as a middle row flower it will render substantial service. Our illustration shows the bloom "undressed," after it had made two journeys by post; but it would have been a very easy matter to have so arranged the florets that the bloom would have presented the high finish properly regarded as essential in the incurved section, but our object in figuring this

INCURVED CHRYSANTHEMUM, ROBERT PETFIELD.

fine variety is to show it grown without manipulation —*The Gardeners' Magazine.*

DR. OLIVER WENDELL HOLMES.

THE venerable Autocrat of the Breakfast Table is honored among the chrysanthemum men of this country for his beautiful addition to the lore of their native flower. Some call him the chrysanthemum poet, but he is of course much better known from his general contributions to the prose and poetry of American—I may say English—literature. He is the last that is left to us of a long line of great American poets, though literature has been more of a pastime than a profession with him. There are many who will be surprised at this, for I am aware it is not generally known that the professor of the breakfast table is also a professor of anatomy and physiology, or that he has taught these important branches of science in some of the leading American colleges for more than forty years. He has, moreover, shown a devotion to real hard work in this line which is far from common. In the course of an address at a "breakfast" given in the poet's honor some years ago, President Eliot, of Harvard University, remarked: "It seems to me that it is my duty to remind all these poets, essayists and story tellers who are gathered here, that the main work of our friend's life has been of an altogether different nature. I know him as the professor of anatomy and physiology in the medical school of Harvard University for the last thirty-two years, and I know him to-day as one of the most active and hard working of our lecturers. Some of you, gentlemen, I observe, are lecturers by profession, at least during the winter months. Dr. Holmes delivers four lectures every week for eight months of the year. I am sure the lecturers by profession will understand that this task requires an extraordinary amount of mental and physical vigor, and I congratulate our friend on the weekly demonstration of that vigor which he gives in our medical school."

Dr. Holmes is not a horticulturist to any great extent, but he loves flowers, especially chrysanthemums, for their beauty alone. The greater part of his life has been spent in and around Boston, where he has had ample opportunity to note the rise and progress of American horticulture. The Massachusetts Horticultural Society operates in that city, but its splendid pioneer work has been felt in all parts of the country. Activity that influenced such a vast territory could not be without its effect on the mind of the keen observer and scientist, and he can appreciate accordingly the efforts of the florists and others to place mankind upon a higher plane. He can, like all broad-minded men, see the utility of seeking a beautiful ideal. He can excuse the wanton follies perpetrated in the name of floriculture, because he knows that they but pave the way to the refinement of art and morals which surely follows. His poems compliment the workers, and it is theirs to press still onward and further merit the generous praise their deeds have won. M. BARKER.

—*The Gardeners' Magazine.*

EFFECTS OF ELECTRIC FLASH LIGHT ON PLANTS.

IN a recent paper read before the Royal Society on "Experiments in Heliotropism," by G. J. Romanes, F.R.S., he says:

I cannot find in the literature of heliotropism that any experiments have hitherto been made on the effects of interrupted illumination, when the periods of illumination are rendered as brief as possible—*i. e.*, instantaneous flashes of light. Accordingly I have conducted an extensive research on heliotropism, where the flashes have been caused either by means of electric sparks in a dark room, or by the opening of a photographic shutter placed before the plants in a camera obscura with an arc light or Swan burner, at a distance of several feet on the other side of the shutter. The electric sparks were made either with a Wimshurst machine, induction sparks, or by means of the following contrivance. From the binding screws of the condenser of a large induction coil copper wires were led to a cup of mercury, where, by means of an electromagnet suitably actuated by clockwork, a current was closed and opened at any desired intervals; each break was therefore accompanied by a brilliant spark. A thick plate of glass was interposed between the seedlings and the electrical apparatus. In all the experiments here described the plants employed were mustard seedlings (*Sinapis nigra*), previously grown in the dark until they had reached a height of between one and two inches. Save when the contrary is stated, in all the experiments comparative estimates were formed by using the same pot of seedlings; during the first half of a comparative experiment half of the seedlings were protected from the light by a cap of cardboard covering half the pot; during the second half of the experiment this cap was removed, and the pot turned round so as to expose the previously protected seedlings to the influence of the light. The principal results thus obtained, and frequently corroborated, were as follows:

I. Even having regard to the fact that for equal strength of a stimulus excitable tissues are more responsive in proportion to the suddenness of the stimulus (or in a kind of inverse proportion to the duration of the stimulus), the heliotropic effects of such flashing stimulation as is above described proved to be much greater than might have been antecedently expected. This was shown to be the case whether the effects were estimated by the rapidity with which the seedlings began to bend after the flashing stimulation was begun or by that with which they continued to bend until attaining a horizontal line of growth, *i. e.* bending to a right angle. Thus at a temperature of 70° F., and in a moist camera, vigorously growing seedlings begin to bend toward the electric sparks ten minutes after the latter begin to pass, and will bend through 45° in as many minutes; frequently they bend through another 45° in as many minutes more. This is a more rapid rate of bending than can be produced in the same pot of seedlings when the previously protected side is uncovered and exposed for similar durations of time, either to constant sunlight or to constant diffused daylight. This is the case even if the sparks (or flashes) succeed one another at intervals of only two seconds.

II. It would thus appear that the heliotropic influence of electric sparks (or flashes) is greater than can be produced by any other source of illumination. But in order to test this point more conclusively, I tried the experiment of exposing one half pot of seedlings in one camera to the constant light of a Swan burner and another half pot of similar seedlings in another camera, placed at the same distance from the same source of light, but provided with a flash shutter working at the rate of two seconds intervals. The amount of bending in similar times having been noted, the pots were then exchanged and their previously protected halves exposed to the constant and the flashing light respectively. In both cases, the rapidity with which the bending commenced and the extent to which it proceeded in a given time after commencement were considerably greater in the seedlings exposed to the flashing than to the constant source stimulation. The same is true if, instead of a Swan burner, the source of light is the sun.

III. Many experiments were tried in order to ascertain the smallest number of sparks in a given time which would produce any perceptible bending. Of course the results of such experiments varied to some extent with the condition of the seedlings. But in most cases, with vigorous young mustard seedlings and careful observation, bending could be proved to occur within fifteen to thirty minutes, if bright sparks were supplied at the rate of only one per minute. The most extreme sensitiveness that I have observed in these experiments was that of perceptible bending after half an hour's exposure to electrical sparks following one another at the rate of fifty in an hour. This result would appear to indicate that in heliotropism under flashing light there need be no summation or "staircase effect;" but that each flash or spark may produce its own effect independently of its predecessors or successors.

IV. It is noteworthy that, while the heliotropic effects of flashing light are thus so remarkable, they are unattended with the formation of any particle of chlorophyl. In the many hundred pots, and therefore many thousands of plants, which have passed under my observation in this research I have never seen the slightest shade of green tinging the etiolated seedlings which had bent toward flashing light. On one occasion I kept a stream of 100 sparks per second illuminating some mustard seedlings continuously for forty-eight hours; and although this experiment was made for the express purpose of ascertaining whether any chlorophyl would be formed under the most suitable conditions by means of flashing light, no change of color in any of the seedlings was produced.

With the exception of those mentioned in the last paragraph, all these results were obtained by using sparks from the coil condenser, as above explained. These sparks were very brilliant, and yielded the maximal results, which alone are here recorded.

SUGAR FROM CORNSTALKS.

AT the present time, when the question of sugar is so prominent in the discussion of economic and financial matters, it seems to me that perhaps it may be worth while to turn our attention to a comparatively forgotten source of supply, and the following results recently obtained at the New York Experiment Station cannot but be of interest to our people.

It may not be generally known that so early as 1717 the General Court of the Colony of Connecticut issued a patent for making molasses from cornstalks, the conditions being that it should be as good and as cheap as could be got from the West Indies. Also that in a letter from Abigail Adams to her husband, John Adams, September 24, 1777, she says:

"An instance may be seen in the progress which is made in grinding cornstalks and boiling the liquor into molasses. Scarcely a town or parish within forty miles of us but what has several mills at work, and had the experiments been made a month sooner many thousand barrels would have been made. No less than eighty have been made in the small town of Manchester. It answers very well to distill, and may be boiled down to sugar. There are two mills fitting up in this parish. They have three rollers, one with cogs and two smooth. The stalks are stripped of the leaves and tops, so that it is no robbery to the cattle, and the juice ground out. It is said that four barrels of juice will make one of molasses, but in this people differ widely. They have a method of refining it so that it looks as well as the best imported molasses."

In 1790 the consumption of sugar in the United States was as follows:

Imported	18,179,632	pounds.
Domestic	12,000,000	"
Total	30,179,632	"
Population	3,929,214	
Per capita consumption	7·68	"

Compare the above statistics with those for the year 1892, when the consumption of sugar was of

Imported	1,593,126	tons.
Domestic	244,500	"
Total	1,837,626	"
Total, 1891	1,872,400	"
Per capita	64·25	pounds.
Per capita, 1891	67·46	"

It will be observed also that while in 1790 we produced about 40 per cent. of our total supply, in 1892 we produced a little over 13 per cent. of what we con-

sumed, and this fact, together with the small per capita consumption, resulted in so slight a tax upon the people for this commodity that the experimental results above recorded were apparently lost sight of and have not received the attention which they appear to have merited.

During the past few years the canning of fresh fruits and vegetables has grown to an extensive industry, and there are many towns throughout the Northern and Middle States having their local factories for the preparation of these products.

I am informed that the factory at Geneva has the past season canned the sweet corn grown upon 425 acres. In order to make a few preliminary experiments, I requested one of those who were daily hauling loads of ears by the station to bring me some average stalks, from which on analysis the following results were obtained:

Stowell's Evergreen.

Juice stripped stalks, per cent	41·1
Sugar in juice, per cent	9·44
Glucose in juice, per cent	2·72
Specific gravity of juice	1·065
Average weight unstripped stalks, ounces	16·7
Average weight stripped stalks, ounces	10·7

Egyptian.

Juice stripped stalks, per cent	44·7
Sugar in juice, per cent	6·88
Glucose in juice, per cent	2·72
Specific gravity of juice	1·049
Average weight unstripped stalks, ounces	28·3
Average weight stripped stalks, ounces	18·2

Hiscock.

Juice stripped stalks, per cent	45·0
Sugar in juice, per cent	10·09
Glucose in juice, per cent	2·32
Specific gravity of juice	1·067
Average weight unstripped stalks, ounces	18·5
Average weight stripped stalks, ounces	11·7

This would give the following in pounds:

Stowell's Evergreen.

Unstripped stalks per acre	15,745
Stripped stalks per acre	10,181
Juice per acre	4,151
Sirup per acre	731
Cane sugar per acre	392

Egyptian.

Unstripped stalks per acre	26,067
Stripped stalks per acre	16,713
Juice per acre	7,474
Sirup per acre	897
Cane sugar per acre	514

Hiscock.

Unstripped stalks per acre	15,725
Stripped stalks per acre	9,988
Juice per acre	4,499
Sirup per acre	697
Cane sugar per acre	454

From the above it will be seen that the average of juice extracted by the small hand mill used in these experiments was approximately 44 per cent. of the weight of the stripped stalks, but a much larger quantity was present in the stalks than that obtained in this way.

It is also to be remembered that the pressed stalks are in an excellent condition for preservation in the silo, and their nutritive value, for an equal weight, is increased rather than diminished by the removal of the 44 per cent. of juice—*i. e.*, a ton of the pressed stalks has a greater nutritive value than a ton of the unpressed stalks; so that we have, in addition, the leaves and tops not only, but the pressed stalks as food for cattle.

It will doubtless surprise many to learn that the juice from cornstalks is purer than that from sorghum, although there is generally a less percentage of sugar in the former than in the latter.—*Peter Collier, in the Country Gentleman.*

HEREDITY.*

By M. F. PRICE, M.D., Colton, Cal.

HEREDITY is defined by Webster to be "Hereditary transmission of the physical and psychical qualities of parents to their offspring: the biological law by which living beings tend to repeat their characteristics in their descendants."

Other definitions may be quoted as follows:

"Hereditary descent or transmission, as of physical or mental qualities; hereditary succession or influence; in biology, the influence of parents upon offspring; transmission of qualities, or characteristics, mental or physical, from parent to offspring. The principle or fact of inheritance, or the transmission of physical or mental characteristics from parent to offspring, regarded as the conservative factor in evolution, opposing the tendency to variation under conditions and environments." (Cent. Dic.)

"By heredity is meant the tendency manifested by an organism to develop in the likeness of its progenitor." (Pop. Sci. Mo.)

"That every unfolding organism eventually takes the form of the class, order, genus and species from which it sprang is a fact which, by force of repetition, has acquired in our minds almost the aspect of a necessity." (H. Spencer.)

In the widest sense, heredity would signify that biological law by which individuals transmit to their posterity *all* the traits that characterize the species to which they belong, making it indispensable to permanence of species. It would include instinct, which is the innate intelligence derived from the experience of progenitors, and also all the characteristics of complexion, feature and mental traits which distinguish races, nations and families of mankind. (Ref. Hd. Bk.)

Generally, however, the definition is restricted to "Transmission of such physical and mental traits as serve to distinguish a few from the main body of their associates."

Just how this transmission of characteristics is accomplished is a difficult problem to solve. Recent researeh has thrown some light upon the structure and relations of male and female germ cells in connection with the phenomena of reproduction and heredity. Henry Fairfield Osborn has investigated the subject under two divisions, viz., that of germ cells—the expression of heredity—and body cells—the potential vehicles of heredity—and says: "The many problems resolve themselves into the simple questions: How do the parent germ cells transform into the offspring body, and how does the latter influence the *new* germ cells, or what are the total relations between the body cells and germ cells?" Galton introduced the term "stirp" to express the sum total of hereditary organic units contained in the fertilized ovum. He advanced the idea of *continuity* in the germ cells, and thus accounts for atavism, the transmission of "latent" characteristics. From this law he claims that "it is evident that only a part of the organic units of the 'stirp' becomes 'patent' in the individual body; some are retained in the germ cells, and only become 'patent' in the next generation or some succeeding generation."

Weisman's theory of heredity is that "there is a distinct form of protoplasm, with definite chemical and molecular properties, set apart as the vehicle of inheritance; this is the germ plasm, quite separate from the body cells. Congenital characters arise in the germ cells, while acquired characters arise in the body cells." (Ref. Hd. Bk.)

Osborn sums up by saying that "the facts of heredity support the theory of a continuous hereditary substance in the protoplasm as the basis of repetition of type, but do not favor Weisman's hypothesis that the germ cells alone contain this hereditary material." (Ref. Hd. Bk.)

There is a prevailing law with regard to the transmission of characteristics governing the species. An individual possessing a given trait to an exaggerated degree, mating with one with the same trait to an average degree, reduces the exaggeration perceptibly, while entire deficiency in the mate would reduce it to still greater extent. On the contrary, if both possessed the same exaggerated trait, the result would be an augmented deviation from the normal type.

Breeders of stock study and take advantage of this law to preserve and improve the purity of choice breeds in speed, size, endurance, docility, strength, fattening and dairy qualities, fineness of wool, etc.

Heredity is noticeable in a variety of traits which belong to certain families. One family is corpulent, another lean; one displays precocity in intellect, another is dull. Aptitude for mathematics, music or the fine arts is often observed to run through several generations. The Bachs were hereditary musicians. Herrick says: "Bad spelling, as well as lewdness, are occasional family traits." Some families are characterized for such virtues as business tact and integrity. The Rothschilds are hereditary bankers. Some families are noted for truthfulness, temperance and frugality; others are equally marked for dishonesty and drunkenness. Vicious and criminal propensities exist in some families for generations. Dr. Dugdale traces through six generations a remarkable example of this form of heredity in the descendants of a depraved woman named Margaret Jukes. Of 709 individuals, the great majority consisted of murderers, thieves, prostitutes and idiots. (Ref. Hd. Bk.)

A short time ago a lady in this city related to me an incident which illustrates this idea. A boy six years of age has a father belonging to the class of men who live on the earnings of fallen women. The boy had been separated from his father for three years and trained by a good mother. He is now living with his aunt, an excellent woman. One day this aunt gave him a nickel to buy some slate pencils. He went for the pencils and, after being a long time away, he came home with some candy also, claiming that he had bought and paid for both. Cross examination failed to elicit any information as to where he procured the extra money. The next morning it was learned that he had picked up a neighbor's pug dog and traded him for the pencils. At the book store he told a straight story about being the owner of the dog and that his aunt did not want him any longer; told the dog's name, etc., and could not be tripped in his story. This boy had been, for three years of his short life, trained under the most favorable circumstances, separated and far removed from the influence of his father and his evil associates. This boy's life will be one of contending elements; his heredity and environments ever at war, or perhaps two hereditary traits opposing each other.

It often happens that all our skill and research are put to the severest test to account for changeable morbid conditions. A patient is hypochondriacal, imaginative, "an instinctive pervert," and persists in declaring himself ill and miserable. We refer it to indigestion, reflex neurosis, etc., and yet "something must be found and acted upon if we would obviate lifelong invalidism." These difficulties may be accounted for by a hereditary transmission of traits of both parents existing separately in the offspring.

Dr. Smith Baker, in a paper read before the American Neurological Association on "Heterogeneous Personality," gives some instances of this double heredity, one of which I will quote. "A little girl about four years old was brought to me as a sort of professional puzzle. She was one whose very bright, beautiful, winsome, affectionate nature had rapidly endeared her to all, and I found her unusually imaginative and inventive, rather precocious as to powers of observation—altogether an attractive child, and without physical abnormality so far as could be discovered. Yet I was informed that she irregularly presented these characteristics: for a few days she would be a normally healthy girl, and a cheery, smooth-tempered playmate of everybody. Then would follow a season, varying in length from a few hours to a couple of days, during which she would manifest all sorts of perversions of bodily function and of mental and moral life. Indigestion, constipation and irritable bladder; bounding heart, flushed cheeks, with no corresponding rise of temperature and no accounting characteristic of urine; fidgety, sleepless, cross, vindictive, dull, but explosive in every direction—apparently another child for the time being—one who had puzzled parents, nurses and physicians, both as regards diagnosis and treatment. Hysteria, hydrocephalus, worms, vaginitis, eye strain, defective valves, Bright's disease, malarial and liver troubles had been the supposed sources as yet most frequently drawn upon to account for the phenomena; while panto-pathic almost had been the methods of attempted relief."

In his investigations Dr. Baker says he adopted almost multitudinous methods, theories and reasonings—local areas of irritation; reflexes, ocular, nasal, sexual, abdominal, cutaneous; the heart, liver, lungs, kidneys; the cerebro-spinal and sympathetic systems—all to be in turn declared barren or wrong. Finally, he thought back upon what he had known of the family antecedents of the child. "Her mother was the only daughter of two people who were so unlike, not only in physique, but also in mental and moral traits, that on the ground of contrast only could their marriage be accounted for." When their daughter, the child's mother, was about fourteen years of age she presented certain functional peculiarities that were very marked, and experienced a series of alternations, during which she would be at times the veritable child of her father, and at others her mother's own child, thus giving a "heterogeneous personality in which, at least, two factors were unblendable in the personal whole." These two "unblendable factors" in the mother were apparently transmitted to the child.

If we but knew it, there are many in our midst among our associates who are leading a double life; the transmitted traits constantly at war with each other, or with the environments of the individual, a double or "duplex consciousness."

In the matter of the transmission of acquired characteristics and mutilations there is great diversity of opinion, but I think there is abundant evidence to prove that they are transmitted to offspring. I know a family with whose history I am familiar for several generations. The individual members have been ordinary "Pennsylvania Dutch" farmers. Some three generations ago one of the boys of a large family left the usual path so long followed and became an educated man by his own efforts, not college educated, but, as Senator Stewart has said, "by contact and association with the people." He adopted and became proficient in a profession. His children are all now in active professional life, proficient and prominent. The same view is also "especially illustrated in the extraordinary contribution of the sons of clergymen to the ranks of men eminent in intellectual attainments."

Much credit is due in such cases to the parental attention paid by the educated to the education of their children. It is hard to separate the influence of heredity from that of the environments.

At the last meeting of this society our worthy President, Dr. C. L. Bard, read a paper in which he recorded the result of some original study bearing upon this subject. This author claims that "in the horse the *trot* is an *acquired* gait which has taken years to perfect. Before his subjugation it was unknown," and that the reindeer is the only animal in which the trot is the natural gait. No one will now pretend to claim that this acquired gait is not transmitted. As before intimated, stock breeders take advantage of this law of heredity, while they are ignorant of the fact that what they try to improve is an acquired characteristic.

About a year ago my little boy procured and brought home a very much emaciated kitten, which had received an injury to the end of its tail. About an inch and a half of the tail was sore, covered with scabs and apparently dead. One day, while the boy was fondling the kitten, the sore end of its tail dropped off. The cat grew and prospered, notwithstanding the abbreviated extremity, and in due course of time became the mother of a litter of kittens, of which two only lived. One of these was born with a tail about half the usual length and the other with the tail in the condition the mother's was when my boy brought her home, and which, like the mother's, dropped off, leaving it like its brother, with a shortened and stumpy tail. These kittens are now six months old, and, with the mother, are quite a novelty in the neighborhood, as well as convincing proof of the hereditary transmission of acquired characteristics.

A lady living near neighbor to me is the possessor of a litter of eight puppies, whose father and mother both have short tails, the result of mutilation. Only two of these puppies have long tails. Of the other six some have short stumps and others no sign of tail.

In Yuma, Arizona, I once knew a family of puppies, about half of which had no tail at all, not even a stump. The mother of the puppies was tailless; the fathers were probably numerous and with long tails.

There is a woman living in my town whose fingers and toes are one phalanx shorter than normal, the nails appearing on the second phalanges of the eight fingers and eight toes, the thumbs and great toes being the usual length. She has two sons and one daughter who inherit the same deformity. On the eighth of September last an illegitimate grandson was born with the toes short, but fingers normal. The fathers in both cases had no deformity. The woman is ignorant and quite sensitive on the subject; therefore I could get no history back of her mother, who, she says, had short fingers and toes.

We are all familiar with the experiments of Weisman with white mice, by which he seemed to prove the contrary of this law. He cut off tails for nine generations and failed to produce a tailless breed.

Some years ago a German physician tried the same experiment with like results. He was led to make the experiment by finding a number of tailless cats in the neighborhood of the Black Forest, and while trying to acertain the cause of the peculiarity he found a litter of kittens, of which some had tails and some had none. While further pursuing the investigation he came across a lady living near who owned a genuine Manx Thomas cat (a tailless breed), and it was to the "gallantry and attentions of this energetic animal that the curtailed cats were due."

The experiment with white mice, detailed above, has since been tried by an American physician with exactly opposite results—the tail disappearing. It could also be made to reappear. In fact it could be bred off or on at pleasure. (Med Abs.)

Brown-Sequard conducted some experiments upon guinea pigs in which the acquired variation was in-

* Read before the twelfth semi-annual meeting of the Southern California Medical Association, held at Los Angeles, December 6 and 7, 1893.—*Southern California Practitioner.*

tensified. He had abnormal degeneration of the toes, muscular atrophy of the thigh, epilepsy, exophthalmos, etc., in the descendants of animals in which the spinal cord or sciatic nerve had been severed, or portions of the brain removed. He also claims to have demonstrated that the female was more apt to transmit the morbid state than the male, and also that they may pass over one generation and reappear in the second, and the influence may continue for five or six generations. (Ref. Hd. Bk.)

Dr. A. L. Hodgdon quotes an interesting case reported by Dr. R. A. Lancaster: "Mr. O. D. M. received a pistol shot wound in the neck near the base of the skull, which came near proving fatal. He finally recovered, however, except that there remains a paralysis of the right side. In walking there is peculiar dragging of the foot, which is quite noticeable. Some years after the accident he was married, and in due course of time a fine healthy boy was born. The mother, who is a very intelligent lady, confesses that she had some misgivings lest the babe might have its father's deformity, which happily was not the case. A second boy was born to them about two years later, and this also was a perfectly formed child. After this *the mother gave no further thought* to the idea of the father's condition impressing itself upon the offspring. About two and a half years later a third son was born, and to the surprise of all—and to none more than to the mother, for she had not given the possibility a thought in the case—he was the exact reproduction of the father, the right arm and leg being somewhat drawn and wasted. The child is now eight years old, and his walk and every motion are precisely like his father's, and no treatment seems to benefit him in the least."

On the subject of "maternal impressions," Dr. Hodgdon appends the following foot-note to this case: "An interesting conclusion might be drawn from what here *occurred after* 'the mother gave no thought,' *opposite* to what happened while she had given thought—warding off the hereditability, as it were, by her fears." I think, however, that it can be better explained by the principle of atavism—part of the "stirp" remaining "latent" in the two and becoming "patent" in the third child, for I am not convinced that there is any truth in the theory of "maternal impressions."

This paper has already reached too great a length to permit of more than a passing note upon the point which is of peculiar interest to physicians—the transmission of disease. My object has been to call attention to facts in heredity that are not often brought to notice. All recognize that numerous diseases are inherited.

Herrick gives a long list: "Of these the most marked are goiter and cretinism, leprosy, gout, scrofula, tuberculosis, cancer, rheumatism, scaly cutaneous affections and the neuroses—epilepsy, insanity, chorea, hysteria and asthma. Heredity is less frequent, but undoubtedly operative in organic disease of the heart, hemophilia and lithiasis. To these should be added color blindness, whose rule of transmission is curious. Females are about one-twenty-fifth as liable to be affected as males, but the color blind transmit their peculiarity to their grandsons through their daughters who have normal color perception, as well as their sons. So this defect recurs in alternate generations in the female line, the females rarely being affected." (Ref. Hd. Bk.)

Some of these diseases are not congenital, and some are absent until old age. It is the predisposition in these cases, not the disease, that is hereditary.

The attention of physicians is perhaps most often called to tuberculosis and insanity of the above list and to syphilis.

Consumption is regarded as a disease of adult life, but in my opinion children are often affected and die of the disease. Of my own two children, one died, at eight months of age, with consumption with all its harassing symptoms—cough, expectoration and emaciation to the greatest degree. The other died at three months with acute phthisis following cold. Their mother died shortly afterward with pulmonary tuberculosis, inherited from her father. Acquired consumption becomes hereditary at once, and the next generation inherits the predisposition to it. I knew a gentleman in Washington City who had five children. The three eldest are now living, well advanced in life. After these three were born the father had a severe pneumonia which left him with a lingering pulmonary trouble that undoubtedly became tuberculous, and with which he finally died. After this had set in two other children were born, both of whom died at twenty to twenty-five years of age with consumption.

Syphilis can be transmitted by the father or mother to the offspring, although Dr. F. R. Sturgis has taught that the father cannot transmit it unless the mother also becomes diseased. I find other authors do not agree with him, nor does my own experience. I have known children who showed all the signs and symptoms of the disease, whose mother, to my certain knowledge, had never been affected.

It has been claimed by some authors that insanity is *always* hereditary, and with this view I am inclined to coincide. Of course, there may be cases of loss of mind from traumatism, or a delirium from disease, which may become chronic and perhaps properly classed as insane, but insanity *per se* is almost, if not always, the product of heredity. The testimony of the relatives of the insane does not amount to much. They will claim that there never was any insanity in the family from "away back" on either side, but such statements are of little value. Insanity is not always recognized, even by neighbors and relatives. They pass as "eccentric," "absent minded," "queer," etc.; but there is a neurotic diathesis that will sometimes show itself in a case of undoubted insanity.

Fielding Blanford says: "Though the parents may not have been insane, they may have been chronic drunkards, epileptics, hypochondriacs, weak-minded, or have indicated their nervous condition by chorea, stammering and the like, and although the parents may not have been insane, insanity may have existed in their parents and reappeared in the grandchildren, skipping a generation." (Insanity and its Treatment.)

It does not follow from this reasoning that the offspring of the insane are all insane; some may be so and others idiotic, epileptic, deaf mutes or simply nervous, and others perfectly sane and sound. "There is a tendency in all diatheses to return to the type of health, if there is sufficient vitality to perpetuate existence, otherwise we should have sterility and finally extinction."

Where this heredity exists, the subject thereof may go through life without its showing itself; but should any exciting cause supervene, such as a severe illness or great mental anxiety, any undue exercise of the emotions, religious excitement; any extreme terror or rage, the mind may become unbalanced and the hereditary tendency assert itself.

If the facts herein presented are true, that mental and physical qualities—morality and vice, virtue and lewdness, perfect and deformed bodies, health and disease—can be transmitted to offspring, as well as the fact that there is no reasonable doubt that the transmission of hereditary disease can be as effectually prevented in the human race as in domestic animals, then the moral I would impress is that the mating of human pairs should be under as wise control as is the breeding of stock. Farmers castrate and spay their ordinary animals, and thus deprive them of their procreative powers; "but the ordinary, diseased and idiotic human is allowed to burden the state with pauper and criminal offspring that become innumerable in the generations of which he is the ancestor." (Walter Lindley, M.D.)

Ella Wheeler Wilcox spoke more wisely, perhaps, than she thought when she said: "I think the best and surest way to reform a man is to begin with his grandparents. If the young woman who is contemplating marriage will take this idea into consideration and act accordingly, she will be saving some other woman a century hence the trouble of reforming her grandson. Nothing is more absurd than for two young people to declare that their love affair is their own business wholly. Results are every day convincing us that the marriage of any two people is an affair which concerns the interest of a whole community. The young woman who runs away with a dissipated or a dishonest man and marries him against the wishes of her friends is not merely causing herself sorrow, but she is causing sorrow for women unborn. Therefore I say, if you wish to reform the world, let us begin with the grandparents of unborn generations."

THE RECIDIVIST.

By JAMES WEIR, Jr.

SOME time since, one of the current magazines published an article under the caption, "Criminals Not the Victims of Heredity." The writer of the abovementioned article, in summing up, advances ten propositions for the proper treatment of criminals, and these ten propositions are founded on the cardinal proposition that "a criminal is like any other man." It is the purpose of the present writer to show, by unimpeachable and incontrovertible evidence, that this last proposition is unquestionably false. The writer referred to makes the common mistake of confounding the various criminal types. He makes an indiscriminate use of the terms professional, habitual and congenital criminal. A professional criminal is not a congenital criminal, nor is a recidivist necessarily a professional criminal. I presume that he means the recidivist all through his article. I will, therefore, endeavor to prove that the congenital recidivist is, anatomically and physiologically, entirely different from normal man. I propose to give facts and facts alone. I do not propose to enter the domain of speculative psychology, nor do I intend to grapple with the grave questions now agitating sociologists and penologists. The statement that the recidivist is, anatomically and physiologically, an abnormal type of man is not the conclusion of an hour or day, but is the rational deduction obtained from days, months and years spent at the dissecting table and microscope, and in the study of the criminal, both in a state of freedom and while incarcerated.

The criminal physiognomy is of so marked a type that most men are able to recognize it at a glance. I took six photographs of criminals (five of them were recidivists and one of them an *occasional* criminal), and showed them to a hundred men, with the following statement and request: "Here are six criminals, five of them are habitual malefactors, and one of them is, comparatively speaking, an honest man: pick out the honest man." Ninety-five men out of the hundred picked out the photograph of the *occasional* criminal without a second's hesitation (*vide New York Medical Record*, "Criminal Anthropology"). The discriminating and exact Maudsley says in "Responsibility in Mental Disease," p. 29: "All persons who have made criminals their study recognize a distinct criminal class of beings, who herd together in our large cities in a thieves' quarter, giving themselves up to intemperance, rioting in debauchery, without regard to marriage ties or the bars of consanguinity, and *propagating* a criminal population of degenerate beings. For it is, furthermore, a matter of observation that this criminal class constitutes a *degenerate or morbid variety of mankind, marked by peculiar low physical and mental characteristics.* . . . . Their *family likeness* betrays them as fellows 'by the hand of nature marked, quoted and signed to do a deed of shame.'"

I have italicized certain words in the above quotation for obvious reasons. A celebrated criminal lawyer of New York once told me that he could tell a recidivist at a glance, and that he never made a mistake in his diagnosis of moral obliquity. Prof. Enrico Ferri, an Italian anthropologist, says that on one occasion he examined several hundred soldiers and found only one whose face declared him to be a criminal. He afterward ascertained that this man had committed murder. Lombroso submitted to thirty-two young girls the photographs of twenty thieves and twenty moral men. Eighty per cent. of these girls recognized the first as malefactors, the second as moral, upright men (*vide* Lombroso, *L'Uomo Delinquente*). Emile Gautier, who was confined for a time in Lyons prison, says: "These criminals have a general *family resemblance*, which makes them a class apart."

A warden of an Eastern penitentiary (Sing Sing) told me that there were not only twins in every prison, but that there were "triplets, quadruplets—aye, even twelvelets" (*sic*)! The criminal physiognomy is alike in all nations. The German criminal is not unlike the Italian, nor is the French unlike the American criminal. Says M. Joly: "I should say that in M. Bertillon's office I was shown nearly sixty photographs of Irish, English and American thieves. It would have been difficult in many cases to discern the Anglo-Saxon *rather than any other physiognomy.*" Now let us analyze the criminal physiognomy, feature by feature, and see what constitutes this universal and well-marked type.

The observations of the writer, when in pursuit of this analysis, were not confined to any particular class of criminals. He examined all classes. He soon found out, however, that this distinctive type was to be found in congenital recidivists alone. The occasional criminal and the professional criminal—*i. e.*, the criminal by calculation—were found to be, anatomically and physiologically, normal. In the recidivist there is a marked exaggeration of the cephalic indices. In a dolichocephalic (long head) recidivist, the dolichocephalism is very marked. A like exaggeration is found in brachycephalic recidivists. Oxycephalism (sugar-loaf head) is very frequently observed. In three hundred drawings, taken from live and dead subjects by the writer, one hundred and ninety-eight are oxycephalic. Lauvergne says of this kind of head: "Where it is complete—that is to say, where it presents a prominent base supporting an inclined pyramid, more or less truncated—this head announces the monstrous alliance of the most eminent faculty of man—genius, with the most pronounced impulses to rape, murder and theft." The bilateral elevation of the sagittal sutures, "Benedikt's lines," have been observed in a number of recidivists. Prof. Benedikt considers these sutural elevations of great importance in criminal anthropology, and in his work *Kraniometrie und Kephalometrie*, says that "though rare, when present they are significant of great moral obliquity."

There is generally marked enlargement in the orbital arches of recidivists, together with receding foreheads. In three hundred and fifty of the four hundred quarter-face photographs of habitual criminals that I have examined, this enlargement of the orbital arches was plainly noticeable. In the two hundred drawings and photographs forming my collection, it is noticeable in one hundred and eighty-two. Tenchini and Lombroso, as well as Benedikt, have pointed out this abnormality in the orbital arches of criminals. Tenchini says that the frontal crest in normal man is 3 to 4 millimeters in length; in criminals, frequently 5 to 6 mm. "It is larger in the lower races, and relatively larger in orang-outangs." In my collection of skulls, there are four skulls of recidivists; all of these show this thickening. Prognathism is a marked characteristic in the physiognomy of the criminal. The large, heavy lower jaw and protruding mouth strike the observer at once. This feature is rarely absent in the congenital criminal. It is an abnormality eloquent in its atavistic suggestiveness. The low, receding forehead, the enlarged orbital arches, the prognathous jaws and high cheek bones of the congenital criminal are strikingly like those of our pithecoid ancestors. Just here it is proper to state that in an article on "Examination and Viraginity," which appeared in the *New York Medical Record*, September 16, I asserted that atavism is found only in individuals of a neurasthenic type. This, in a measure, is true in all cases of reversion; but it is well to remember that in the article alluded to I had reference to psycho-sexual atavism only. Sexual perversion and psychic hermaphroditism are of frequent occurrence in the recidivist; I do not intend, however, to discuss them here. I have examined, macroscopically and microscopically, twenty-three criminal brains. Twenty of these brains were those of recidivists, and abnormalities were found in all of them. In one of them, taken from a criminal executed for attempted rape and murder, there was confluence of the fissures. In a number of them the frontal lobe presented four convolutions; in all of them there was deficiency in weight. In several the gray matter was scanty and thin, and the convolutions superficial and few in number. Havelock Ellis says: "A variety of pathological features have been found in the cerebral substance and membranes—pigmentation, degenerating capillaries," etc. He then adds, in conclusion: "It must be added, as a point of considerable importance, that in very few cases" (he is speaking of the criminal class) "have these pathological lesions produced any traceable symptoms during life." There are two kinds of abnormal ears found in the criminal type: large outstanding ears, like those of the chimpanzee, and ears small and closely applied to the skull, like those of the gorilla. I have found that the small ear is generally possessed by the pickpocket and the sneak-thief, while the large ear is possessed by the burglar with murderous tendencies. In all my experience I have never seen an habitual petty thief with a large ear, while all burglar-murderers whom I have examined had large ears. A prison keeper said to me on one occasion: "I can tell a thief from a murderer every time by the size and shape of his ears."

I have thirty-six sketches of pickpockets. These drawings were made from life and are drawn to scale, and in all of them the ear is small and frequently misshapen. One sketch, made of a convict now in an Indiana penitentiary, shows the strange abnormality of a forked helix. Féré and Sêgelas present a cut of an ear somewhat like the sketch just mentioned. The ears of recidivists are apt to be abnormal in many respects. Most of these abnormalities are undoubted atavistic attempts. Especially is this true of the small gorilla-like ear and the large projecting chimpanzee-like ear. The recidivist has a peculiar, feral stare, which, once seen and noted, can never be forgotten. A noted detective (Bligh, of Louisville, Ky., now dead) called it the "ape eye." "Look," said he to me on one occasion when were discussing criminals; "look at the next ape you see and you will know what I mean." (*sic*). The congenital criminal, when looking at you, seems to focus his sight on a point beyond you. It is difficult to describe this look. Bligh's "ape eye" comes nearer to it than anything else I can think of. Some of the special senses in recidivists are very much exaggerated.

The hearing of twenty-eight congenital criminals tested by me with the watch was found to be more acute than normal. Some of them possessed the microscopic sight of birds, describing the appearance of minute objects correctly, the details of which, to be seen, rendered for me the use of a lens absolutely necessary. I may add that my eyes are normal. Others

were able to read the printed Snellen's type double the normal distance. The sense of smell was decidedly more acute than normal. I bathed my hands in water scented with a few drops of violet perfume; they were then carefully dried. Three billiard balls were then held in the hands for a few moments, and then deposited on a table with half a dozen others. Thirteen recidivists out of twenty-eight picked out the balls which had been handled, declaring that they could plainly distinguish the violet odor. This experiment had been tried before with normal men, none of whom picked out the balls. I once knew a recidivist in St. Louis who could tell his friends by their personal odors. I have seen him do this time and again.

Spencer, in his "Sociology," gives a like instance of acuteness of smell in savages. I had the skull of this St. Louis recidivist in my cabinet for several years. It was stolen, however, and is now, probably, in the possession of some medical college or museum. It was strikingly like the skull of the Man of Spy (*vide Man in the Glacial Period*, Wright, p. 277), and was an extraordinary instance of atavism in every structural characteristic. There are two features yet remaining in the criminal physiognomy which I ought to have mentioned before discussing the special senses. We have all noticed the aged appearance of criminals, whether young in years or old. This appearance is due to the wrinkles that form about the mouth and eyes. Here the resemblance to the anthropoid apes again crops out. I have known youthful criminals so wrinkled that, in this respect, they resembled normal men five times their a.e. In aged recidivists there appears on the upper eyelid, at the inner angle, a triangular fold or wrinkle. This wrinkle I have repeatedly noticed on the upper eyelids of the larger anthropoid apes. It is rarely present in normal man. High cheek bones are other prominent features in the criminal physiognomy. They are seldom absent in the congenital recidivist.

I have now analyzed the physiognomy of the recidivist feature by feature. When I place each feature in its proper place, I construct a mosaic of a variety in the human race entirely different from normal man. The brain, the seat of the moral function, is involved as well as bone, nerve and tissue. I have not carried this analysis of the congenital criminal beyond the head and face. I have said nothing of color (pallor), of the hair, of cutaneous sensibility, of the form and shape of the extremities, and of numerous other abnormalities. Without this additional evidence I think that I have proved that the congenital recidivist is *not* "like any other man." It is a principle of logic that one cannot combat assertions which are unsupported by arguments. The article referred to in the beginning of this paper is made up of assertions, the bases of which are founded on personal beliefs. It is the old story of religion against science; the old mistake of separating mind and brain matter, when, in fact, the two are identical. I am not an Averroist, nor am a believer in the doctrines of emanation and absorption. But I do believe, and this belief can be proved to be correct, that wherever there are receptive ganglia, whether in organisms high or low in the scale of animal life, there this element of life, which the Greeks called ψῦχη, psyche, enters in. It is just as much under the dominion and control of evolution as is the body, and is subject to the same laws. Morals are the result of evolution and are, unquestionably, a mental function subject to the laws of evolution. I regard the congenital recidivist as a moral imbecile, rendered such by the phenomenon of atavism.

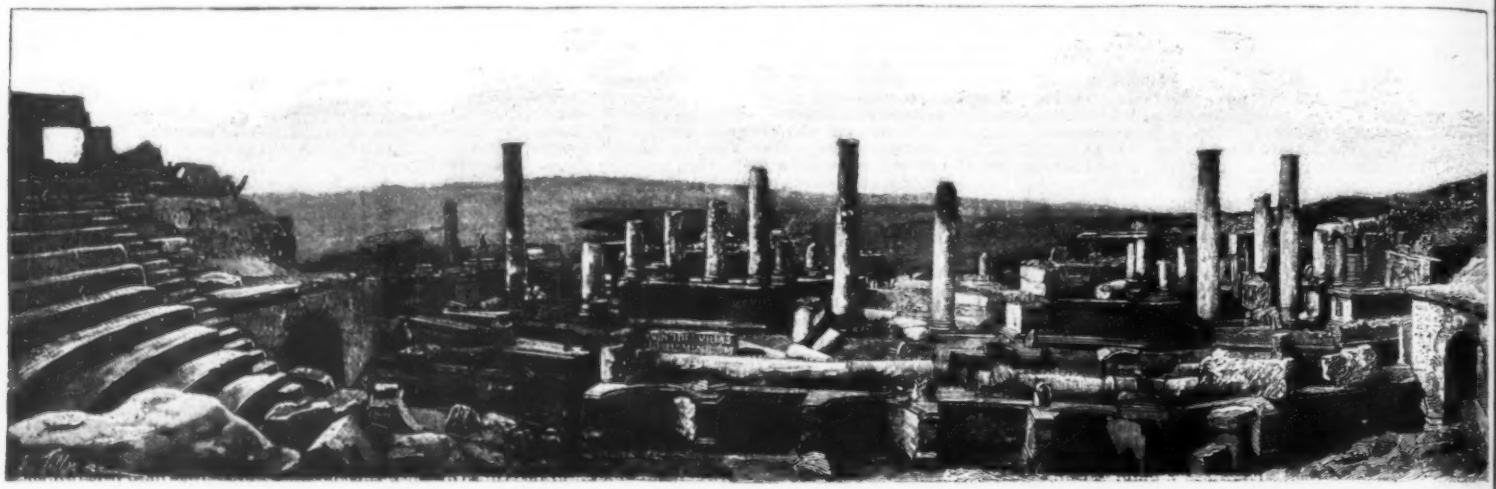
EXCAVATIONS AT DOUGGA.

DR. CARTON, one of the most distinguished of archæologists, recently communicated to the Academy of Inscriptions and Belles-lettres the results of the excavations directed by him in Tunis in the course of a mission intrusted to him by the Minister of Public Instruction.

At Dougga, a village situated at a short distance from Tunis, Dr. Carton disengaged the ruins of several Roman edifices of the greatest interest, and, among others, a theater in a surprising state of preservation for its age. It is this structure that our engravings represent under two aspects.

Almost entirely buried at first, it showed nothing but the upper benches and the heads of a few columns of the stage that remained standing. Upon having a stratum of rubbish five meters in depth and more than two thousand cubic meters of earth removed, the explorer laid bare the *cavea* (the part appropriated to the spectators), with twenty-five perfectly intact rising stone benches and a stage twenty-five meters in width. The latter was paved with a mosaic of white slabs provided with a green border. Of the forty columns that stood in the center as well as in the *proscenium*, twenty-five still remain. Externally, on three sides, it is surrounded by a promenade six meters in width. The dependencies, that is to say, the foyer, six stairways leading to it and the wings, were likewise unearthed. Among the vestiges exhumed must be mentioned a colossal statue of excellent workmanship, but unfortunately headless. Moreover, precise inscriptions were everywhere found. One of them, at the foot of the statue of the Emperor Probus, celebrates the prosperity of the empire. Another, running over the arcades of the *summa cavea*, makes known the approximate date of the construction under Marcus Aurelius. A third, placed upon the frieze of the portico of the stage, recalls the fact that Marcius Quadratus, in memory of his elevation to the dignity of *flamen perpetuus*, erected this theater at his expense, and enumerates the rejoicings that he offered on the occasion of the inauguration.

The edifice measures no less than seventy-five meters in its greatest dimensions. It is remarkable, not only for its architecture, but also for its situation. From the top of the benches one takes in these majestic ruins at a glance, and, through the colonnade of the stage, like a superb scene-painting, he perceives the valley of the Khalledk and the mountain of Sidi Cheidi. Dr Carton, by his patient labors, deserves well of archæologists and tourists.—*L'Illustration.*



RUINS OF THE ROMAN THEATER AT DOUGGA—THE STAGE.

RUINS OF THE ROMAN THEATER AT DOUGGA—THE CAVEA, OR PART RESERVED FOR THE SPECTATORS.

THE NEW REICHSTAG BUILDING, BERLIN.

THE exterior of the new Reichstag building, a production of Paul Wallot's, is now complete. It is executed in that style of architecture that was evolved from those forms of the Italian renaissance once handled in such masterly manner by Pallado and Sanmichele. The structure stands on the Koingplatz, near the Brandenburg gate of Berlin, in sight of the triumphal column, a proud monument to German unity, and it will be, for centuries, a reminder of the great times that inflamed the national feeling, inciting patriots to struggle with the enemy, and inspiring art.

The prize offered for the first competition of designs for a Reichstag building was won by Ludwig Bohnstedt, of Gotha, who has since died; but in the second competition Paul Wallot, then an architect in Frankfort, was successful. His design, however, had to be altered somewhat before it was entirely satisfactory, and even after the laying of the corner stone, on June 9, 1884, Wallot had to make some changes.

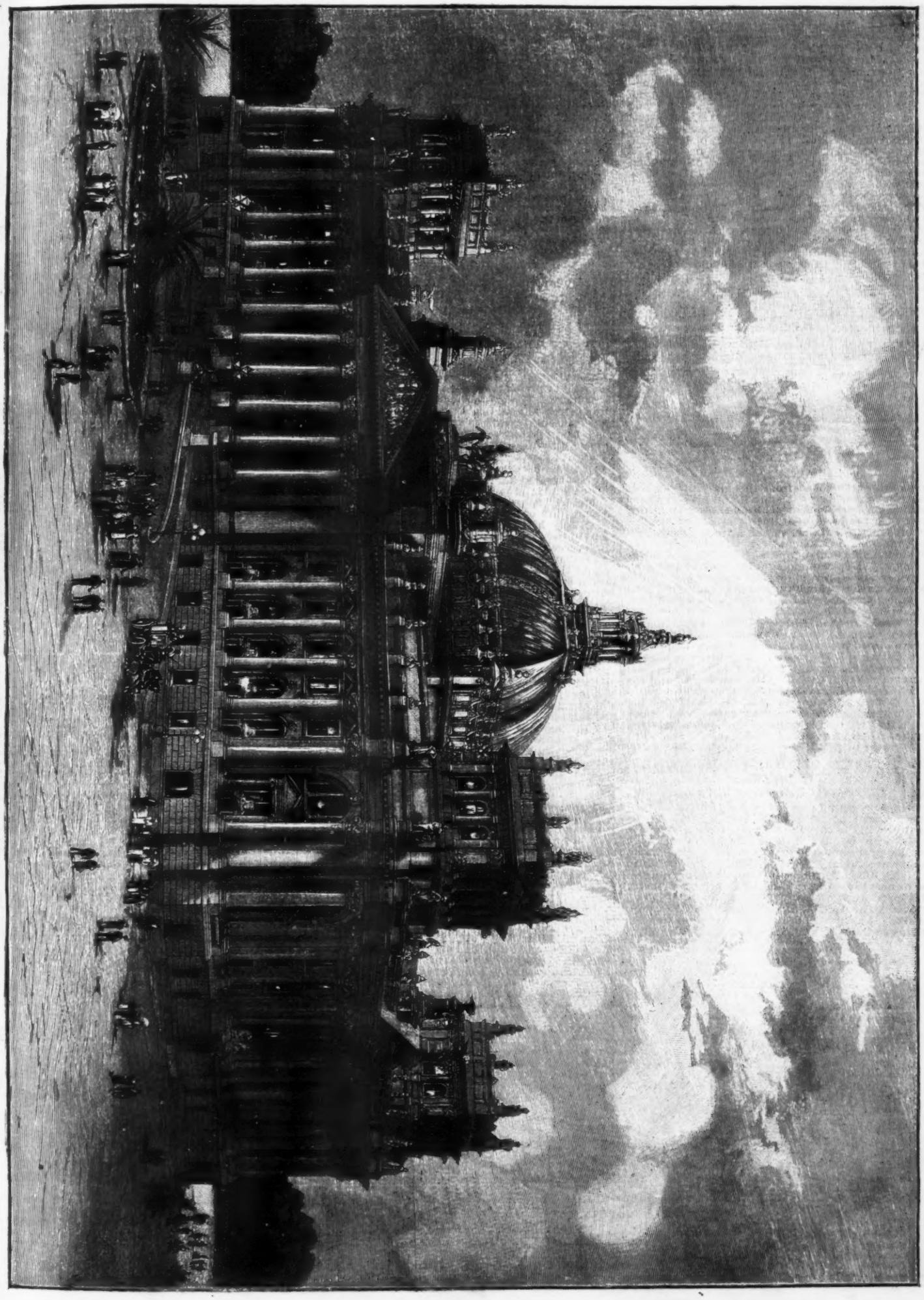
The beautiful sandstone building forms a rectangle about 433 feet long by more than 288 feet wide. From the accompanying engraving a good idea of the style of architecture can be obtained. Square towers extend high above the roof at the four corners, having the effect of corner pillars, and forming a fine contrast to the gilded dome in the center, which is crowned by a richly gilded lantern, a charming little tower, the summit of which carries the imperial crown. On the two visible sides of each of the corner towers there are symbolical statues, figures in sandstone more than 12 feet high, representing the powers of state; those on one tower represent defense by water and by land, the administration of justice and the science of government; those on the second, the ethical element of the civilization of a nation, bringing up of children, education, art and literature; on the third, the sources of food supply, agriculture, cattle breeding, beer and wine; and on the fourth, commerce and industry—the great industries and trade in connection with navigation, electricity, and the small home industries are represented. This colossal work was executed by the sculptors Maison, Volz, Schierholz, Behrens, Lessing, Diez, Eberlein and Eberle. It will be seen that artistic skill has been brought from all parts of the empire to execute the task worthily.

The Koingplatz front, which is really the main front, is divided by half columns, and over the large arched windows of the main floor there are only the windows of one other story. The other fronts are divided by pilasters, and above the windows of the main floor there are windows of two other stories. In the center of each front there is a richly decorated portal, which constitutes its chief architectural beauty.

Over the three doors on the Koingplatz there is a pediment supported on great pillars, and very richly ornamented. Above this pediment will be placed the colossal group of Germania, seated man-fashion on a horse, and accompanied by two heroic figures. The dome forms a fine background for this group, which was modeled by Reinhold Begas and executed in cop

per by Seitz. It was sent to the Chicago Exposition. On each side of the group there will be pedestals supporting the insignia of the empire chiseled in sandstone. The surface of this pediment is well covered with particularly fine decorations designed by Prof. Schaper and chiseled in sandstone by the sculptor a knight fighting manfully with the dragon "Strife;" higher up an inscription relating to the construction of the building, and in the front wall of the vestibule are to be two genealogical trees modeled by Prof. Lessing and so placed as to be visible between the outer pairs of columns. One of these trees will represent an oak and the other a pine; on the former will be the coat of arms of the North German States and the other that of the South German States. Father Rhein will rest at the foot of the oak, and the personification of the Weichsel at the foot of the pine.

In comparison with the wealth of decoration on this portion, the rest of the front is, of course, very simple, but the colossal heads by Prof. Wiedemann, of Frankfort, on the keystones of the arches over the windows of the main floor are especially fine; being well chosen emblems of the rivers and streams of the Fatherland. The front is completed by the two towers with their



THE NEW GERMAN REICHSTAG BUILDING, BERLIN—WEST (MAIN) FACADE.—PLANS DRAWN BY PAUL WALLOT.

Lock. In the center is a shield bearing the national eagle and protected by two figures of heroic size, and above the shield are the crown and baldachin. On each side is a noble group; one representing art and trade, and on the other, science and agriculture. Inside, above the middle door, will be seen the figure of immense pillars carrying statues, while above all rise groups of boys bearing aloft the imperial crown. The latter were modeled by the sculptor Brutt.

The long front on Sommerstrasse is plainer, but here also the portal is more highly decorated than the rest of the facade. In the three arches, back of which

is the landing leading to the door, will be bronze statues of Bismarck, Moltke and Roon, in sitting postures. High above the middle structure, on pedestals, there will be the colossal figures of two heralds mounted on horseback, waving their banners enthusiastically, and on each of the side walls there will be enormous coats of arms of the German empire accompanied by heroic figures.

The portal on the Koingplatz will be the entrance used on ceremonious occasions, and that on Sommerstrasse will be used by members of the Imperial House and the members of the Bundesrath. The members of the Reichstag will use the entrance in the south front nearest the Brandenburg gate. The fronts facing north and south are the smaller ones. The portals on these sides are also very beautiful, each having a pediment resting on a group of columns, and on the field of the pediment is the German eagle stretching his wings over the four kingdoms symbolized by their coats of arms. On each side of both pediments is a pedestal bearing an eagle that has swooped down on a snake. The fronts of these pedestals are decorated with the initials of Emperor William I. entwined with laurel. Directly above one entrance will be an allegorical group representing "Strength," and over the other a group representing "Wisdom." The effect of these fronts is grand and beautiful.

The artist planned the interior with no less grandeur. Work on this part is being busily pushed forward, because the building is to be ready for occupancy by next fall. A model of the building, prepared by G. Berger, was sent to the Chicago Exposition.—*Illustrirte Zeitung.*

A CURIOUS PHENOMENON OF ELECTRIFICATION.

MR. F. DROUIN points out a curious phenomenon of electrification that occurs when a gelatinized photo-

graphic print is detached from the glass upon which it has been dried for enameling. The glass becomes so strongly electrified that small sparks can be drawn from it with the hand, that it may be used as an electrophorus plate, and that it will attract light bodies at a distance of three inches.

The best method of performing the experiment is the following: Take a photographic print upon gelatine paper and apply it to glass under water in the same way as for ordinary enameling, and allow it to dry perfectly, that is to say, for twelve or fifteen hours.

The whole is then laid upon two supports (two books, for example), the print upward, and under the glass are placed bits of paper or elder pith. The print is then detached in the usual manner (there is no need at all of operating rapidly), and the light bodies rush under the glass. A carbon print transferred to glass will, when detached, give rise to the same phenomenon. If the print is not doubled, it is found that the thin film of gelatine is strongly attracted to its former place, if it is left to itself during the operation.—*Les Inventions Nouvelles.*

THE JEFFREY ELECTRIC COAL MINING MACHINE.

IN no country in the world is the commercial value of machinery better understood than it is in the United States. There no sentimental feeling prevents the substitution of the machine for a dozen men, when the machine can be had. American capitalists have learned long since that the men will not spare them, and they accordingly dispense with labor as far as in them lies. Just now the coal strike has led English mine owners to see much good in American methods, and Messrs. John Davis & Son, All Saints' Works, Derby, are now introducing the Jeffrey coal cutting machine. It is now, and has been for some time, at work in the Cannock and Rugeley Colliery, where it is holing 4 ft. deep by 3 ft. wide at an average speed of three minutes. The time occupied in resetting the machine is only three or four minutes, so that in straightforward work ten cuts are made per hour, equivalent to 120 square feet per hour. How much coal can be brought down depends on the thickness of the seam; but we are informed that in the United States, where the machine has been at work some years, and where some of the largest collieries are wholly worked by Jeffrey machines, the men contract in thick seams to hew 240 tons of coal per machine in two shifts per day. Furthermore, it is stated that the cost of maintenance and repairs is about three farthings per ton.

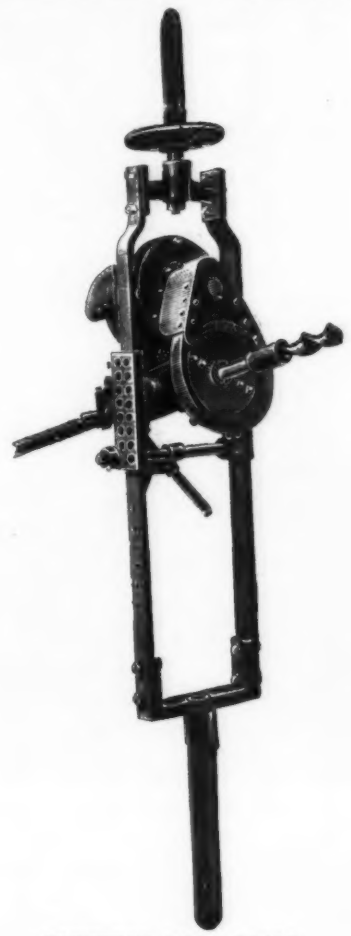
The construction of the mac ine will be readily understood from our illustrations, which are reproductions of photographs of the Cannock and Rugeley machine. The "holing," or undercutting, is done by a horizontal bar armed with cutting blades, which is seen at the front end of the machine, and is caused to revolve rapidly by endless chains. These chains are driven either by an electric motor or by air engines. The two outside chains are used to remove the coal dust. The bent bar with a hand wheel seen near the end of the machine is not a pick, but a strut, by which the machine is secured in its place, and held up against the thrust set up by the action of the cutter bar.

To go into details, we may say that the machine consists of a bed frame occupying a space 2 ft. wide by 8 ft. 6 in. long, composed of two steel channel bars firmly braced, the top plates on each forming racks with their teeth downward, in which the feed wheels of the sliding frame engage. Mounted upon and engaging with this bed frame is a sliding frame, similarly braced, consisting mainly of two steel bars, upon which are mounted at the rear ends an electric motor, from which power is transmitted through straight gear and a worm wheel to the rack, by means of which the sliding frame is fed forward. Upon the front end of this sliding frame is mounted the cutter bar, held firmly by two solid steel shoes, with suitable brass boxes. The cutter bar is fitted with bits, made of tool steel, held in place by set screws. The cutter bar is caused to revolve by an endless curved link steel chain from the driving shaft, and as it is revolved is advanced by the mechanism into the coal or other material to be undercut to the desired depth. The cutter bar may be driven, as we have said, either by electricity or compressed air.

The electric motor occupies a space about 20 in. square. The current required is from 30 to 50 amperes at a pressure of 220 volts; each motor is wound to develop fully 15 horse power, though frequently in some veins of coal the machine only uses 30 amperes or 7½ horse power in making cuts. The machine is started by means of a switch fixed on a suitable resistance box on the rear end of the motor. The current is gradually turned on by simply passing the lever over buttons. The armature of the motor is calculated to run at a speed of 1,000 revolutions per minute, from which the speed is reduced, so as to run the cutter bar 200 revolutions per minute. The momentum of the armature is such that ordinary obstructions met by the cutter bar in the coal are not perceptible, and the machine runs steadily and comparatively quietly. The machines are run by two men, one man in charge and the other as helper. Trucks are furnished with the machines, so that they can be handled with ease. The machine is taken into the mine upon this truck, and run into the room to be undercut; it is then placed on two boards in front of the coal at one side of the room, and fastened firmly by means of the front and rear jacks, which are braced against the face and roof of the coal; this prevents the machine from moving while in operation; the power is then turned on by the machine runner, and the machine proceeds to its work.

The cutter, which is revolved by an endless chain, is fed forward by means of the rack-and-pinion wheels to a depth of 5 ft. or 6 ft., according to the size of the machine; the usual length of the cutter bar is 39 in. and 42 in., and when the full depth has been reached the feed is thrown off, and by means of a reverse lever the cutter bar is withdrawn to its starting place. This completes the cut, and the machine is moved over the length of the cutter bar used, and another cut is made in the same manner. Thus the work is continued until the entire width of the room has been undercut, after which the machine is again loaded on the truck and taken into another room. These cuts are made on an average of from four to six minutes each. The amount of coal undercut, or the lineal feet face for each machine, depends upon the quality of the coal and the skill of the men handling the machines. In some coal veins the machines have cut at the rate of 130 and 150 lineal feet face in ten hours to a depth of 6 ft. Twice this amount can be cut if the machines are run on double shift. The construction is very simple, so that any person of ordinary intelligence can understand and handle it with a few days' instructions.

When compressed air is used, the electric motor is replaced by a double cylinder engine, with cylinders 5 in. diameter and 5½ in. stroke. In other respects both machines are alike. We may add that the coal

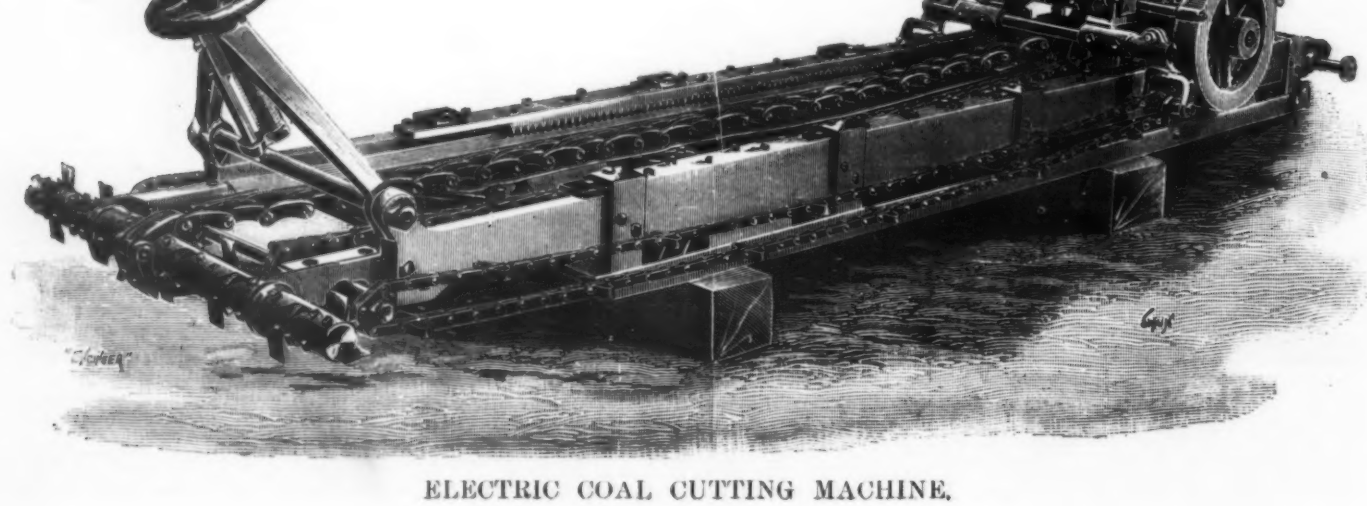


ELECTRIC COAL DRILL.

cutter is made in two sizes, one stronger, heavier, and capable of doing more work than the other.

We also illustrate a drill for blasting in mines, the construction of which will be understood at a glance. This drill has a small electric motor hung in an upright frame, having projections at top and bottom, arranged with adjusting screws by means of which it is fastened to the roof and floor of the mine. This is supported by a brace to stiffen and hold the frame rigid while the drill is in operation, although in low veins, with short posts, this brace would not be needed.

The motor is of the iron-clad type, and will develop 1½ horse power at a pressure of 220 volts, but can be wound for a lower or higher voltage to suit plants already installed. The working parts, including the field coils and armature, are inclosed, with the exception of the commutator brush holders and terminal con-



ELECTRIC COAL CUTTING MACHINE.

nectors, the latter being covered by a sheet iron hood, thus preventing dirt and pieces of coal from damaging the armature and field coils. There are but few parts to the motor, and these are easily replaced. The armature and field coils are insulated in the best manner, and all danger of a burned or grounded coil is, it is claimed, obviated. The motor is not incumbered with a starting resistance or rheostat, as one is not required. The auger runs at about 300 revolutions per minute, and bores a 2 in. hole 6 ft. deep in from two to four minutes.

It will be understood that none of these machines are new and untried. They are, we believe, quite new in this country, but they are well-known in the States, and the Jeffrey Manufacturing Company, Columbus, Ohio, is a large and well established company, which has made mining machinery of all kinds a specialty for many years. The first Jeffrey machine put to work in this country was started in November last. In the United States it is said to have reduced the cost of sending coal to bank to 3s. per ton—a very important fact, considering what wages are in the States.

It would be quite superfluous to point out the advantages of machine holing over hand work; all mine owners and engineers recognize that. The difficulty has lain hitherto in getting a machine to do the work. So far as can be seen, the Jeffrey machine solves the problem, and we hope it will, in the long run, settle the question of machine holing.—*The Engineer, London.*

ELECTRIC TRANSFER TABLE.

WE illustrate below a very fine electrically driven transfer table, constructed at the Industrial Works, Bay City, Michigan, U.S.A.

The table has a length of 70 ft., and is supported upon sixteen chilled tread wheels, each 36 in. in diameter, 4 in. flat treads, and ground accurately to this diameter. Upon either side of the supporting wheels are placed in pairs 15 in. I beams. To these cross

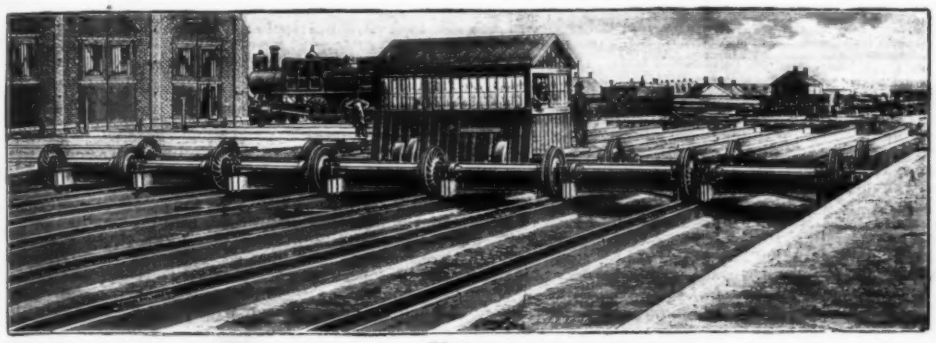


FIG. 1.

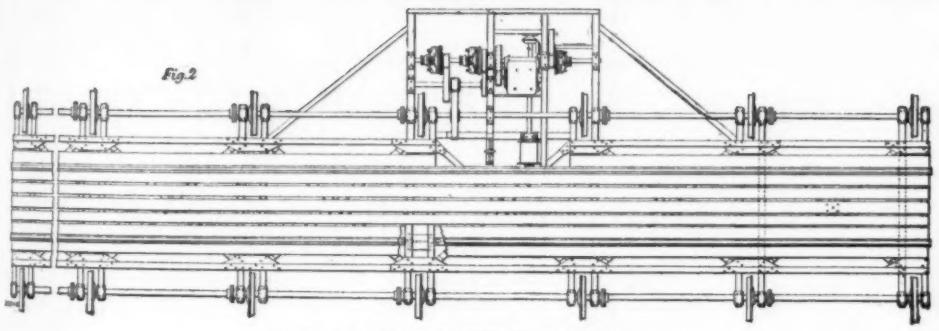


Fig.2

ELECTRIC TRANSFER TABLE.

beams are riveted the longitudinal beams to which the track is fastened. The framework of the table is of a design to carry 110 tons distributed over a distance of 64 ft.

Necessary power for the propulsion of this table, with two speeds for minimum and maximum loads and for drum attachment for pulling cars on and off, is supplied by an electric motor of 35 horse power, placed as shown. All the motions are transmitted to the longitudinal shaft, either in a forward or reverse direction, by friction clutches. Through these means, without stopping the motor, a minimum speed of 90 ft. per minute for maximum loads may be given, and a maximum speed of 250 ft. for light loads.

A very similar transfer table was installed in the Transportation building of the World's Columbian Exposition of 1893, and was placed in service during the month of December, 1892. From that time until June 5, 1893, it was used continuously, and much of the time, night and day, in placing the heaviest locomotives, cars, and exhibits in the Transportation building. This table moved with ease and dispatch the heaviest locomotive exhibits, weighing 110 tons. The total weight of exhibits handled by it was 51,275,000 pounds.—*Engineering.*

EFFECT OF ELECTRICITY ON STEAM.

AT a recent meeting of the Royal Society of Great Britain J. J. Thomson described the following experiment, showing the effect of electricity on steam: A current of steam was passed through the middle limb of a T-tube, the closed side limbs of which were furnished with delivery tubes and also with gold or platinum electrodes, between which sparks might be passed through the steam. The delivery tubes conducted the gases into two eudiometers, in which the gaseous mixture formed on passage of the sparks was exploded. When the sparks were from 1·5 to 4 millimeters long it was observed that within the limit of error of the experiment the volumes of the excess of hydrogen in the one tube and of oxygen in the other, which remain after the explosion of the mixed gases, are respectively equal to the volumes of the hydrogen and oxygen liberated in a water voltmeter placed in series with the steam tube, and that the excess of hydrogen appears in the tube which is in connection with the positive electrode, the excess of oxygen in the tube which is in connection with the negative electrode. When the spark length is greater than 4 millimeters, the first of the preceding results ceases to hold, and when the spark length is increased to over 11 millimeters, the excess of hydrogen, instead of appearing at the positive electrode, changes over to the negative, the excess of oxygen at the same time going over from the negative to the positive electrode. When the sparks are very much longer, about 22 millimeters, reversal again takes place, the hydrogen appearing at the positive electrode. The author finds that when the arc discharge passes through hydrogen and oxygen respectively, the hydrogen behaves as if it had a negative charge and the oxygen as if it had a positive one.

ELECTRO-CHEMICAL EFFECTS ON MAGNETIZING IRON.*

By THOMAS ANDREWS, F.R.SS.L. and E.

EXPERIMENTS WITH MAGNETIC POLAR TERMINALS.

IN course of an earlier part of this research, the author made many preliminary experiments to investigate the possible electro-chemical effect between the polished end disks or alternate polar terminals of straight round steel magnets when immersed as elements in some electrolytes, only the north and south terminal planes of each steel magnet being simultaneously exposed to the action of the electrolyte.

Indications were afforded, under certain conditions, of a tendency on the part of the N. terminal of the magnet to become from some cause electro-positive to the S. terminal plane.

The magnets were placed parallel at some distance apart in an upright position, the lower end of each magnet, exposed in the solution, was covered with black India rubber tubing, so that the flat polished terminal disks only were exposed to the action of the electrolyte. The bars used for the magnets were of polished steel, 4¼ inches long, $\frac{5}{16}$ inch diameter, cut adjacently, previous to magnetization, from a longer bar. A pair of magnets were securely placed in a wooden frame, and the N. and S. terminals of each bar immersed in the solution placed below. A number of experiments were made with the arrangement, and with a galvanometer in circuit, using a pair of new steel magnets each time. In these observations the current appeared to flow from the N. to the S. polar terminal; care was exercised to insure that the magnets were as near as practicable equally magnetized.

The indications of the apparent tendency of the N. pole to become electro-positive in an electrolyte appeared somewhat singular, and after communicating these preliminary results to Prof. G. G. Stokes, and conferring with him thereon, it was decided to make further experiments, and in course of these I have endeavored to utilize some valuable experimental suggestions which Prof. Stokes kindly made.

Prof. Stokes suggested that the results noticed in the first set of experiments might probably be accounted for in the following manner, thus: Supposing the bars to be equally magnetized permanently, then when the magnet bars were placed in the upright position the magnetism induced in the bars by the earth's magnetic force would in one magnet strengthen and in the other oppose the permanent magnetism, so that the stronger pole would be the N. one at the bottom. To investigate this possible aspect of the matter, an apparatus was constructed with which to conduct the further investigations. The arrangement consisted of a wooden stand, the thick upper crossbar of which was hollow and formed a tank sufficiently capacious to hold a suitable quantity of the electrolyte. The ends of two magnetized steel bars were securely inserted from below through the two holes in the bottom, so that the upper terminal disks only of the magnets were exposed to the solution. These holes were very accurately and carefully drilled, and when the bars were forced in, the arrangement was quite fluid tight, and the greatest care was exercised to insure that the terminal planes only of the magnets were exposed to the action of the solution. The steel rods were connected with a galvanometer which was introduced into the circuit, and the electrolyte was then poured into the upper receptacle and the readings of galvanometer noted. A new wooden stand was prepared for each experiment, and a new pair of steel magnets was also employed for each observation. In many experiments the electrolyte was first introduced to the lower ends of the bars, and observations first taken of the relative electro-chemical positions of the N. and S. terminals at the lower end of the magnets. The solution was afterward removed, the lower bar ends cleaned, and the electrolyte subsequently placed in the upper receptacle. By this means an indication of the relative electro-chemical position of both the upper and lower polar disks of the same pair of steel magnets was afforded.

In course of the investigations it was frequently noticed that an instantaneous fling of the galvanometer occurred on first immersing the bars in the electrolyte, the fling showing the S. polar terminal to be positive at the moment of commencing the experiment; this instantaneous fling of the galvanometer very rapidly subsided, and the subsequent readings showed a continuously steady positive position for the N. pole. It will also be generally noticed that the E. M. F. steadily increased from the commencement of an experiment, when the electrolyte was placed either above or below the magnets, the polar influence appearing gradually and increasingly to affect the action taking place. An examination of the results of the total observations, on the steel magnets, in which the electrolyte (cupric chloride solution) was placed below the magnets, gave an average E. M. F. of 0·014 volt; whereas the observations made with the electrolyte above the magnets yielded an average E. M. F. of 0·011 volt. Further experiments were also confirmatory of this difference in the extent of E. M. F.

The general results seem, therefore, to indicate that the positivity of the upper N. polar terminal was reduced relatively to some extent when the electrolyte was placed above the magnets, and this circumstance may possibly be owing to the action of the upper N. pole having been comparatively weakened by the influence of the earth's magnetism, as suggested by Prof. Stokes. This difference, ascertained from the results of such a considerable number of observations, in the extent of the E. M. F. may perhaps thus be accounted for. It will be seen that the united results lead to the tentative conclusion that there was a general tendency, under the conditions of experimentation, on the part of the N. magnetic terminal of the steel magnets to assume electro-chemically the positive position compared with the S. terminal, when these constituted elements in certain electrolytes. The result was seemingly due to the magnetic poles diversely influencing the action of the solution on the metal; and in the case of the copper salts the ratio of the electro-deposition of the copper was apparently affected by these magnetic influences.

* Abstract of paper in the *Proceedings* of the Royal Society.

STRENGTH LOST BY THE TWIST.

ACCORDING to experimental research, it appears that we can only obtain about 30 per cent. of the total amount of fibers composing a thread of any given size. This verdict gives one a strong desire to refute it. When we consider the degree of perfection to which we have brought all our cotton machinery, the actual intelligence displayed by the various movements, the sensitiveness exhibited in the manipulation of the fibers, from the raw condition, through each process, converging and placing the fibers in closer contact in order to fit them to withstand the strain to which they will be subjected when they finally arrive at the point where size, cleanliness and order show they are suitable for the twist which is to bind them into one, and then to find that, with all our care and skill, as soon as the association is formed, instead of adding to the strength of the fibers, we have really taken away some 70 per cent., is to depart forever from the old saying that "Union is strength."

If we take a cross section of a thread of any counts, numbering the fibers and multiplying the weight that one of them will sustain without breaking by the total number of fibers, the aggregate strength should result; but this is only the theoretical strength, because we take it for granted that each fiber has the same amount of resistance or degree of strength. Now, this is a fallacy. Fibers are neither of the same length nor diameter, nor, in fact, of the same matured condition in growth in the same pod. This determines the tensile properties of individual fibers, but the question is why do we not get a higher percentage of strength in our yarns? Well, if we notice how fibers are combined and twisted round one another through their entire length, we are convinced that they suffer some alteration in their structure. All fibers are not completely and securely entwined throughout their entire length, and, owing to the manner of union as a thread, their tenacity cannot be as great as it would be if more intermingling could be adopted, similar to braiding them together.

The point of resistance when a strain is applied is not at the extremity of each fiber, as when tested separately, where each fiber merely sustains its own weight. In a thread some of this resisting power is spent in direct opposition to each other, thus weakening and lessening their united strength. If the fibers are straight, as they are when separate, the elasticity is complete, but in the thread this is not the case, because all do not stretch alike; some become ruptured sooner than they would if the rest possessed more elasticity, that is in a cross section at that point. It may be said further that all fibers at the point of rupture do not break at once, and some not at all, but simply pull away from the rest, and here we fail to realize what would remedy this great deficiency, for if we twist them so that they shall all break at once we shall be in a worse plight than before. In any and every case excessive twist will diminish the strength of any thread however spun.

What we have said about the great disparity between the actual and theoretical strength of yarns may be of some value to students and operatives. The

loss is not due to our neglect or incompetency as spinners, but to an inevitable combination of circumstances, although an increase of strength might be obtainable, but for the pernicious custom adopted of putting in too much twist. A very inferior staple is so twisted to make it adhere together, but the yarn is trashy and unfit for any fabric but the very lowest that can be woven.

The constant twist factor, whether it be 3·25 or 4, or any other figure, is not to be depended upon; in fact, spinners of well-known ability alter according to the fiber they have to contend with—the only use of the factor is as a mere guide. Too much twist is loss to spinners, and, in a woven fabric, in place of increasing the strength of the cloth, whether used as warp or weft, its tendency is to weaken it to a great extent. The extremes are carried out both ways, and the reason for this is that there is and always has been a diversity of opinion. One advocates plenty of twist, another a medium amount, while a third declares he cannot sell any yarns except those that are soft twisted.—*Textile Industries.*

[FROM THE AMERICAN JOURNAL OF SCIENCE.]

THE INTERNAL WORK OF THE WIND.*

By S. P. LANGLEY.

PART I.—INTRODUCTORY.

IT has long been observed that certain species of birds maintain themselves indefinitely in the air by "soaring," without any flapping of the wing or any motion other than a slight rocking of the body; and this, although the body in question is many hundred times denser than the air in which it seems to float with an undulating movement, as on the waves of an invisible stream.

No satisfactory mechanical explanation of this anomaly has been given, and none would be offered in this connection by the writer, were he not satisfied that it involves much more than an ornithological problem, and that it points to novel conclusions of mechanical and utilitarian importance. They are paradoxical at first sight, since they imply that under certain specified conditions very heavy bodies entirely detached from the earth, immersed in and free to move in the air, can be sustained therein indefinitely, without any expenditure of energy from within.

These bodies may be entirely of mechanical construction, as will be seen later, but for the present we will continue to consider the character of the invisible support of the soaring bird, and to study its motions, though only as a pregnant instance offered by nature to show that a rational solution of the mechanical problem is possible.

Recurring, then, to the illustration just referred to, we may observe that the flow of an ordinary river would afford no explanation of the fact that nearly inert creatures, while free to move, although greatly denser than the fluid, yet float upon it; which is what we actually behold in the aerial stream, since the writer, like others, has satisfied himself by repeated observations that the soaring vultures and other birds appear as if sustained by some invisible support in the stream of air, sometimes for at least a considerable fraction of an hour. It is frequently suggested by those who know these facts only from books that there must be some quivering of the wings, so rapid as to escape observation. Those who do know them from observation are aware that it is absolutely certain that nothing of the kind takes place, and that the birds sustain themselves on pinions which are quite rigid and motionless, except for a rocking or balancing movement involving little energy.

The writer desires to acknowledge his indebtedness to that most conscientious observer, M. Mouillard,* who has described these actions of the soaring birds with incomparable vividness and minuteness, and who asserts that they under certain circumstances, without flapping their wings, rise and actually advance against the wind.

To the writer, who has himself been attracted from his earliest years to the mystery which has surrounded this action of the soaring bird, it has been a subject of continual surprise that it has attracted so little attention from physicists. That nearly inert bodies, weighing from 5 to 10, and even more, pounds, and many hundred times denser than the air, should be visibly suspended in it above our heads, sometimes for hours at a time, and without falling—this, it might seem, is without misuse of language, to be called a physical miracle; and yet the fact that those whose province it is to investigate nature have hitherto seldom thought it deserving attention is perhaps the greater wonder.

This indifference may be in some measure explained by the fact that the largest and best soarers are of the vulture kind, and that their most striking evolutions are not to be seen in those regions of the northern temperate zone where the majority of those whose training fits them to study the subject are found. Even in Washington, however, where the writer at present re-

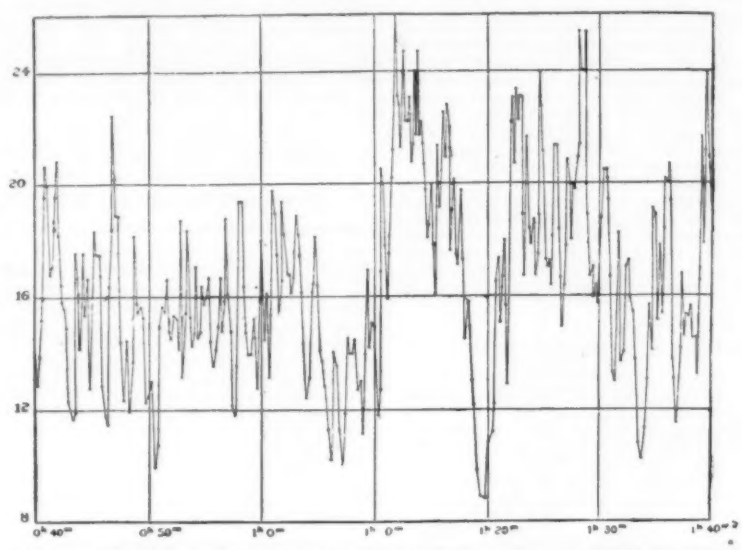


FIG. 1.—Wind velocities recorded July 16, 1887, at the Allegheny Observatory, with a Robinson anemometer registering every 25 revolutions.
Abscissæ = time. Ordinates = wind velocities in miles per hour.

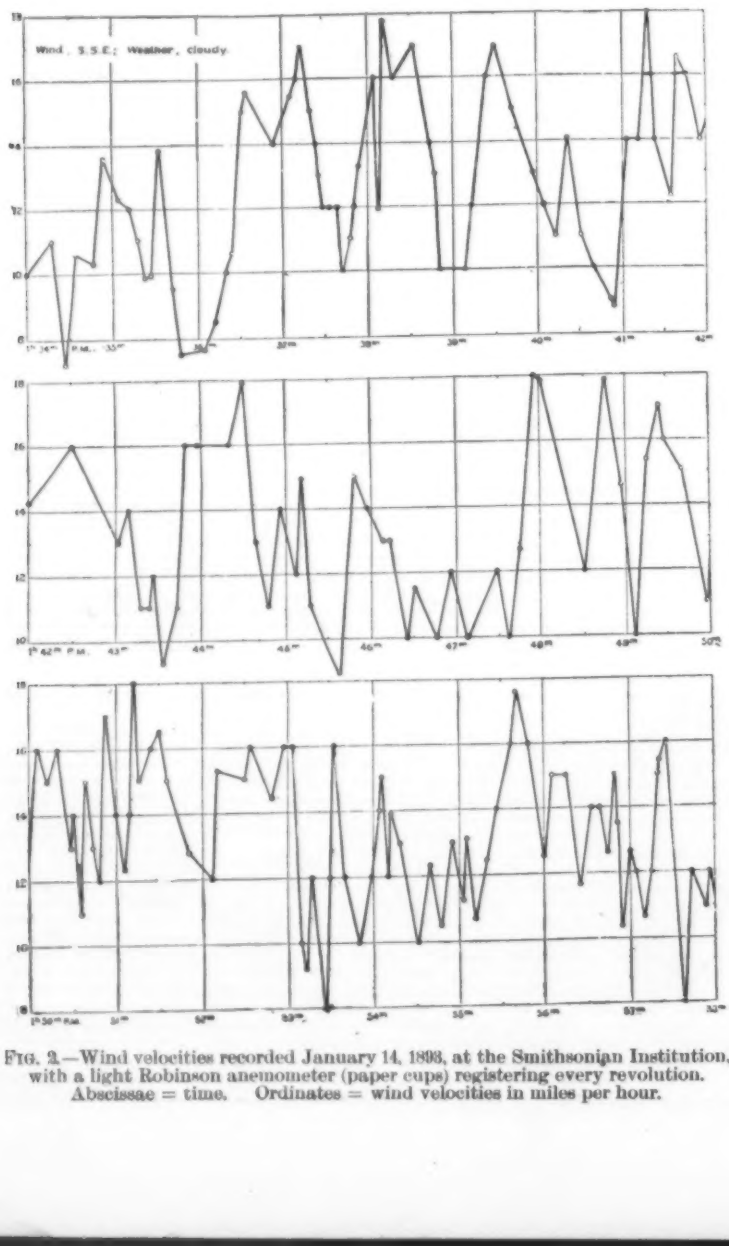


FIG. 2.—Wind velocities recorded January 14, 1893, at the Smithsonian Institution, with a light Robinson anemometer (paper cups) registering every revolution.
Abscissæ = time. Ordinates = wind velocities in miles per hour.

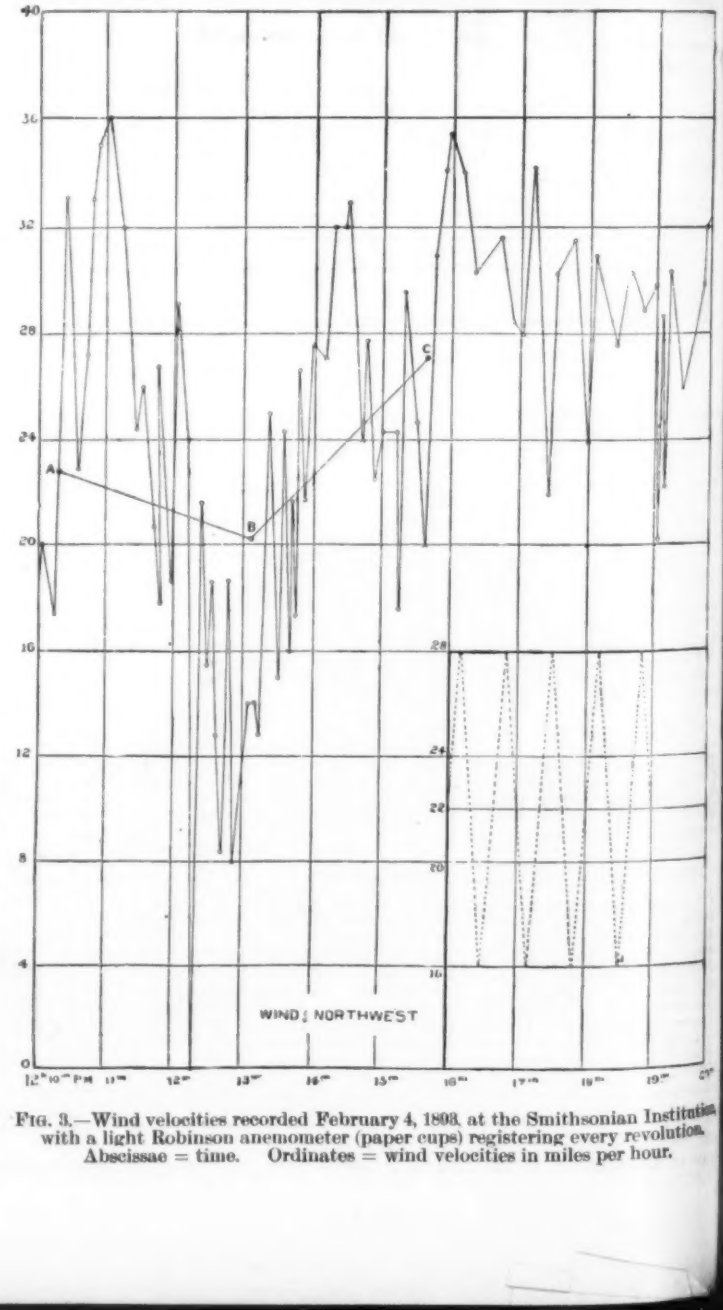


FIG. 3.—Wind velocities recorded February 4, 1893, at the Smithsonian Institution, with a light Robinson anemometer (paper cups) registering every revolution.
Abscissæ = time. Ordinates = wind velocities in miles per hour.

* A paper read (by title only) to the National Academy of Sciences, in April, 1893, and subsequently (in full) at the Aeronautical Congress, at Chicago, in August, 1893.

* L. P. Mouillard, "L'Empire de l'Air." Paris, G. Masson.

sides, scores of great birds may be seen at times in the air together, gliding with and against the wind, and ascending higher at pleasure, on nearly motionless wings. "Those who have not seen it," says M. Mouillard, "when they are told of this ascension without the expenditure of energy, are always ready to say, 'but there must have been movements, though you did not see them;'" "and in fact," he adds, "the casual witness of a single instance, himself, on reflection, feels almost a doubt as to the evidence of his senses, when they testify to things so extraordinary."

Quite agreeing with this, the writer will not attempt any general description of his own observations, but as an illustration of what can sometimes be seen, will give a single one, to whose exactness he can personally witness. The common "turkey buzzard" (*Cathartes aura*) is so plenty around the environs of Washington that there is rarely a time when some of them may not be seen in the sky, gliding in curves over some attractive point, or, more rarely, moving in nearly straight lines on rigid wings, if there be a moderate wind. On the only occasion when the motion of one near at hand could be studied in a very high wind, the author was crossing the long "Aqueduct Bridge" over the Potomac, in an unusually violent November gale, the velocity of the wind being probably over 35 miles an hour. About one-third of the distance from the right bank of the river, and immediately over the right parapet of the bridge, at a height of not over 20 yards, was one of these buzzards, which, for some object which was not evident, chose to keep over this spot, where the gale, undisturbed by any surface irregularities, swept directly up the river with unchecked violence. In this aerial torrent, and apparently indifferent to it, the bird hung, gliding in the usual manner of its species, round and round, in a small oval curve, whose major axis (which seemed toward the wind) was not longer than twice its height from the water. The bird was therefore at all times in close view. It swung around repeatedly, rising and falling slightly in its course, while keeping, as a whole, on one level, and over the same place, moving with a slight swaying, both in front and lateral direction, but in such an effortless way as suggested a lazy yielding of itself to the rocking of some invisible wave.

It may be asserted that there was not only no flap of the wings, but not the quiver of a wing feather visible to the closest scrutiny, during the considerable time the bird was under observation, and during which the gale continued. A record of this time was not kept, but it at any rate lasted until the writer, chilled by the cold blast, gave up watching and moved away, leaving the bird still floating about, at the same height in the torrent of air, in nearly the same circle, and with the same aspect of indolent repose.

If the wind is such a body as it is commonly supposed to be, it is absolutely impossible that this sustention could have taken place in a horizontal current any more than in a calm, and yet that the ability to soar is in some way connected with the presence of the wind became to the writer as certain as any fact of observation could be, and at first the difficulty of reconciling such facts (to him undoubted) with accepted laws of motion seemed quite insuperable.

Light came to him through one of those accidents which are commonly found to occur when the mind is intent on a particular subject, and looking everywhere for a clew to its solution.

In 1887, while engaged with the "whirling table" in the open air at the Allegheny Observatory, he had chosen a quiet afternoon for certain experiments, but in the absence of the entire calm which is almost never realized, had placed one of the very small and light anemometers made for hospital use in the open air, with the object of determining and allowing for the velocity of what breeze existed. His attention was called to the extreme irregularity of this register, and he assumed at first that the day was more unfavorable than he had supposed. Subsequent observations, however, showed that when the anemometer was sufficiently light and devoid of inertia, the register always showed great irregularity, especially when its movements were noted, not from minute to minute, but from second to second.

His attention once aroused to these anomalies, he was led to reflect upon their extraordinary importance in a possible mechanical application. He then designed certain special apparatus herafter described, and made observations with it which showed that "wind" in general was not commonly what it was assumed to be, that is, air put in motion with an approximately uniform velocity in the same strata; but that, considered in the narrowest practicable sections, wind was always not only not approximately uniform, but variable and irregular in its movements beyond anything which had been anticipated, so that it seemed probable that the very smallest part observable could not be treated as approximately homogeneous, but that even here there was an internal motion to be considered, distinct both from that of the whole body and from its immediate surroundings. It seemed to the writer to follow as a necessary consequence that there might be a potentiality of what may be called "internal work"* in the wind.

On further study, it seemed to him that this internal work might conceivably be so utilized as to furnish a power which should not only keep an inert body from falling, but cause it to rise, and that while this power was the probable cause of the action of the soaring bird, it might be possible through its means to cause any suitably disposed body, animate or inanimate, wholly immersed in the wind, and wholly free to move, to advance against the direction of the wind itself. By this it is not meant that the writer then devised means for doing this, but that he then attained the conviction both that such an action involved no contradiction of the laws of motion and that it was mechanically possible (however difficult it might be to realize the exact mechanism by which this might be accomplished).

It will be observed that in what has preceded it is intimated that the difficulties in the way of regarding this even in the light of a theoretical possibility may have proceeded, with others as with the writer, not from erroneous reasoning, but from an error in the premises, entering insidiously in the form of the tacit assumption made by nearly all writers, that the word "wind" means something so simple, so readily intelligible, and so commonly understood as to require no special definition; while, nevertheless, the observations which are presently to be given show that it is, on the contrary, to be considered as a generic name for a series of infinitely complex and little known phenomena.

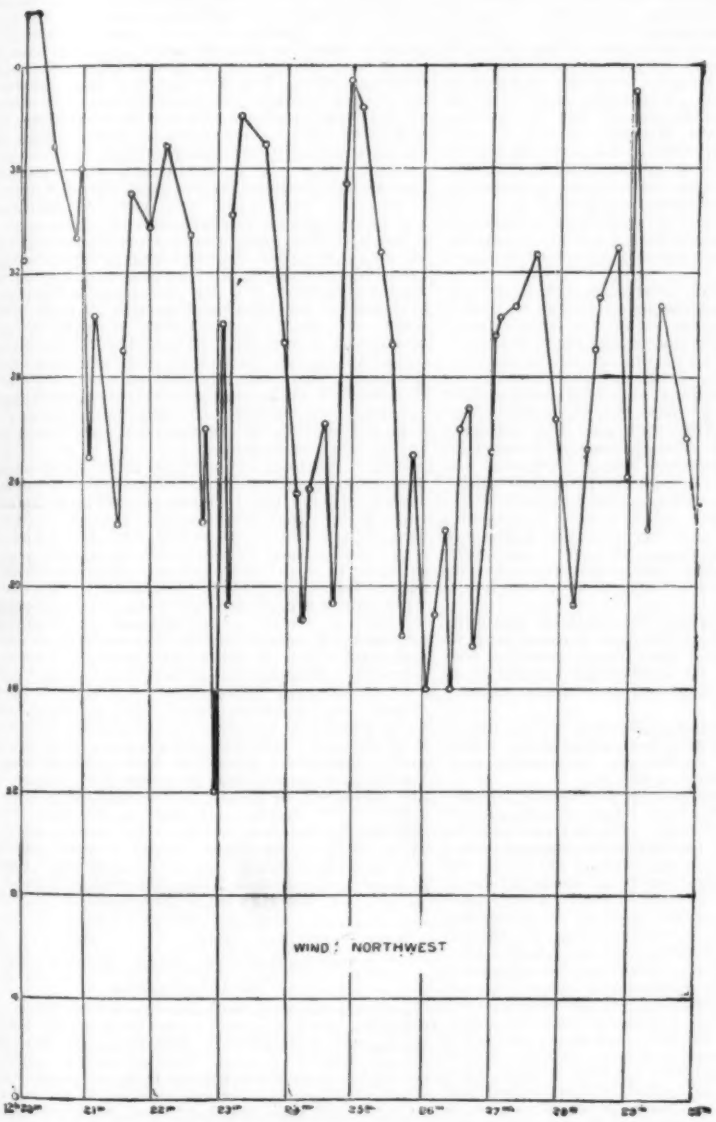


FIG. 4.—Wind velocities recorded February 4, 1893, at the Smithsonian Institution, with a light Robinson anemometer (paper cups) registering every revolution. Abscissae = time. Ordinates = wind velocities in miles per hour.

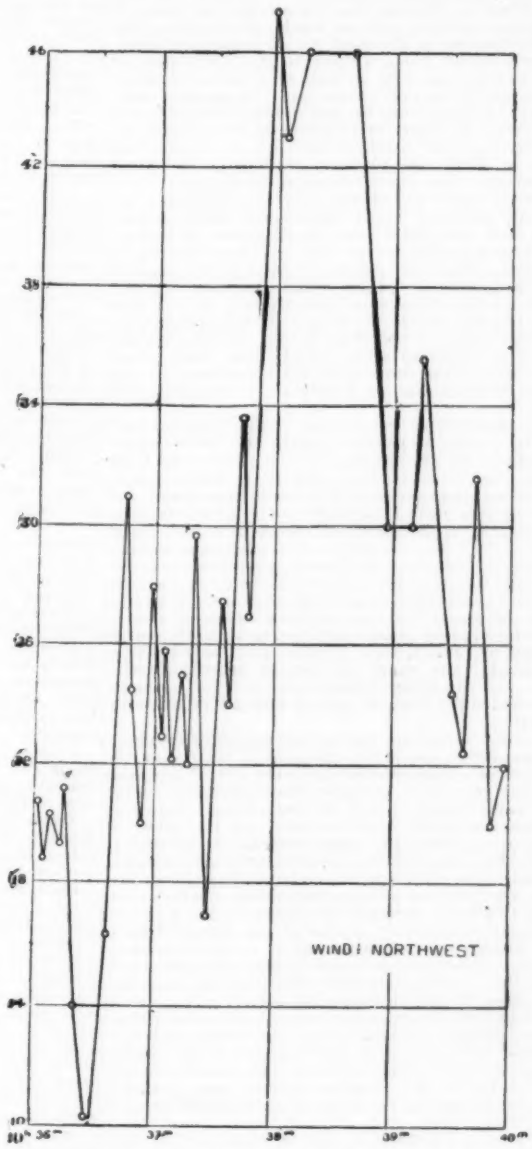


FIG. 5.—Wind velocities observed at Smithsonian Institution, February 20, 1893, with a Robinson anemometer (aluminum cups) registering every five revolutions. Abscissae = time. Ordinates = wind velocities in miles per hour.

* Since the term "internal work" is often used in thermo-dynamics to signify molecular action, it may be well to observe that it here refers not to molecular movements, but to pulsations of sensible magnitude, always existing in the wind, as will be shown later, and whose extent and extraordinary possible mechanical importance it is the object of
trate. The term is so significant of the author's
himself the use of it here, in spite of the poss-

Without determining here whether any mechanism can be actually devised which shall draw from the wind the power to cause a body wholly immersed in it to go against the wind, the reader's consideration is now first invited to the evidence that there is no contradiction to the known laws of motion, and at any rate no theoretical impossibility in the conception of such a mechanism, if it is admitted that the wind is not what it has been ordinarily taken to be, but what the following observations show that it is.

What immediately follows is an account of evidence of the complex nature of the "wind," of its internal movements, of the resulting potentiality of this internal work, and of attempts which the writer has made to determine quantitatively its amount by the use of special apparatus, recording the changes which go on (so to speak) *within* the wind in very brief intervals. These results may, it is hoped, be of interest to meteorologists, but they are given here with special reference to their important bearing on the future of what the writer has ventured to call the science of aerodromics.*

* ... ἀεροδρομος, an air

The observations which are first given were made in 1887 at Allegheny and are supplemented by others made at Washington in the present year.*

What has just been said about their possible importance will perhaps seem justified, if it is remarked (in anticipation of what follows later) that the result of the present discussion implies not only the theoretical, but the mechanical possibility, that a heavy body wholly immersed in the air and sustained by it, may, without the ordinary use of wind, or sail, or steam, and without the expenditure of any power except such as may be derived from the ordinary winds, make an aerial voyage in any direction, whose length is only limited by the occurrence of a calm. A ship is able to go against a head wind by the force of that wind, owing to the fact that it is partly immersed in the water, which reacts on the keel, but it is here asserted that (contrary to usual opinion and in opposition to what at first may seem the teachings of physical science) it is not impossible that a heavy and nearly inert body *wholly* immersed in the air can be made to do this.

The observations on which the writer's belief in this mechanical possibility are founded will now be given.

PART II.—EXPERIMENTS WITH THE USE OF SPECIAL APPARATUS.

In the ordinary uses of the anemometer—let us suppose it to be a Robinson's anemometer, for illustration—the registry is seldom taken as often as once a minute; thus, in the ordinary practice of the United States Weather Bureau, the registration is made at the passage of each mile of wind. If there be very rapid fluctuations of the wind, it is obviously desirable, in order to detect them, to observe the instrument at very brief intervals, *e. g.*, at least every second, instead of every minute or every hour, and it is equally obvious that in order to take up and indicate the changes which occur in these brief intervals, the instrument should have as little inertia as possible, its momentum tending to falsify the facts by rendering the record more uniform than would otherwise be the case.

In 1887 I made use of the only apparatus at command—an ordinary small Robinson's anemometer, having cups 3 inches (7·5 cm.) in diameter, the center of the cups being 6¾ inches (16¼ cm.) from the center of rotation. This was placed at the top of a mast 53 feet (16·2 meters) in height, which was planted in the grounds of the Allegheny Observatory, on the flat summit of a hill which rises nearly 400 feet (122 meters) above the valley of the Ohio River. It was, accordingly, in a situation exceptionally free from those irregularities of the wind which are introduced by the presence of trees and of houses or of inequalities of surface.

Every twenty-fifth revolution of the cups was registered by closing an electric circuit, and the registry was made on the chronograph of the observatory by a suitable electric connection, and these chronograph sheets were measured and the results tabulated. A portion of the record obtained on July 16, 1887, is given on Fig. 1, the abscissæ representing time and the ordinates wind velocities. The observed points represent the wind's velocities as computed from the intervals between each successive electrical contact, as measured on the chronograph sheets, and for convenience in following the succession of observed points they are here joined by straight lines, though it is hardly necessary to remark that the change in velocity is in fact, though quite sharp, yet not in general discontinuous, and the straight lines here used for convenience do not imply that the rate of change of velocity is uniform.

The wind velocities during this period of observation ranged from about 10 to 25 miles an hour, and the frequency of measurement was every 7 to 17 seconds. If, on the one hand, owing to the weight and inertia of the anemometer, this is far from doing justice to the actual irregularities of the wind; on the other, it equally shows that the wind was far from being a body of even approximate uniformity of motion, and that even when considered in quite small sections, the motion was found to be irregular almost beyond conception—certainly beyond anticipation; for this record is not selected to represent an extraordinary breeze, but the normal movement of an ordinary one.

By an application of these facts, to be presented later, I then reached by these experiments the conclusion that it was theoretically possible to cause a heavy body wholly immersed in the wind to be driven in the opposite direction, *e. g.*, to move east while the wind was blowing west, without the use of any power other than that which the wind itself furnished, and this even by the use of plane surfaces, and without taking advantage of the more advantageous properties of curved ones.

This power, I further already believed myself warranted by these experiments in saying, could be obtained by the movements of the air in the horizontal plane alone, even without the utilization of currents having an upward trend. But I was obliged to turn to other occupations, and did not resume these interesting observations until the year 1893.

Although the anemometer used at Allegheny served to illustrate the essential fact of the rapid and continuous fluctuations of even the ordinary and comparatively uniform wind, yet owing to the inertia of the arms and cups, which tended to equalize the rate (the moment of inertia was approximately 40,000 gr. cm.²) and to the fact that the record was only made at every twenty-fifth revolution, the internal changes in the horizontal component of the wind's motion, thus representing its potential work, were not adequately recorded.

In January, 1893, I resumed these observations at Washington with apparatus with which I sought to remedy these defects, using as a station the roof of the north tower of the Smithsonian Institution building, the top of the parapet being 142 feet (43·3 meters) above the ground, and the anemometers, which were located above the parapet, being 153 feet (46·7 meters) above the ground. I placed them in charge of Mr. George E. Curtis, with instructions to take observations under the conditions of light, moderate, and high winds. The apparatus used was, first, a Weather Bureau Robinson anemometer of standard size, with aluminum cups. Diameter to center of cups, 34 cm.; diameter of cups, 10·16 cm.; weight of arms and cups, 241 grammes; approximate moment of inertia, 40,710 gr. cm.²

A second instrument was a very light anemometer, having paper cups, of standard pattern and diameter, the weight of arms and cups being only 74 grammes, and its moment of inertia 8,604 gr. cm.²

With this instrument a number of observations were taken, when it was lost by being blown away in a gale. It was succeeded in its use by one of my own construction, which was considerably lighter. This was also blown away. I afterward employed one of the same size as the standard pattern, weighing 48 grammes, having a moment of inertia of 11,940 gr. cm.², and finally, I constructed one of one-half the diameter of the standard pattern, employing cones instead of hemispheres, weighing 5 grammes, and having a moment of inertia of but 300 gr. cm².

In the especially light instruments, the electric record was made at every half revolution, on an ordinary astronomical chronograph, placed upon the floor of the tower, connected with the anemometer by an electric circuit. Observations were made on January 14, 1893, during a light wind having a velocity of from 9 to 17 miles an hour; on January 25 and 26, during a moderate wind, having a velocity of from 16 to 28 miles an hour; and on February 4 and 7, during a moderate and high wind ranging from 14 to 36 miles an hour. Portions of these observations are given on Figs. 2, 3 and 4. A short portion of the record obtained with the standard Weather Bureau anemometer during a high northwest wind is given on Fig. 5.

A prominent feature presented by these diagrams is that the higher the absolute velocity of the wind, the greater the relative fluctuations which occur in it. In a high wind the air moves in a tumultuous mass, the velocity being at one moment perhaps 40 miles an hour, then diminishing to an almost instantaneous calm, and then resuming.*

The fact that an absolute local calm can momentarily occur during the prevalence of a high wind was vividly impressed upon me during the observations of February 4, when chancing to look up to the light anemometer, which was revolving so rapidly that the cups were not separately distinguishable, I saw them completely stop for an instant, and then resume their previous high speed of rotation, the whole within the fraction of a second. This confirmed the suspicion that the chronographic record even of a specially light anemometer at most but imperfectly notes the sharpness of these internal changes. Since the measured interval between two electric contacts is the datum for computing the velocity, an instantaneous stoppage, such as I accidentally saw, will appear on the record simply as a slowing of the wind, and such very significant facts as that just noted will be necessarily slurred over, even by the most sensitive apparatus of this kind.

However, the more frequent the contacts, the more nearly an exact record of the fluctuations may be measured, and I have, as I have stated, provided that they should be made at every half revolution of the anemometer, that is, as a rule, several times a second.†

I now invite the reader's attention to the actual records of rapid changes that take place in the wind's velocity, selecting as an illustration the first 5½ minutes of the diagram plotted on Fig. 3.

The heavy line through points, A, B and C, represents the ordinary record of the wind's velocity, as obtained from a standard Weather Bureau anemometer during the observations recording the passage of two miles of wind. The velocity, which was at the beginning of the interval considered nearly 23 miles an hour, fell during the course of the first mile to a little over 20 miles an hour. This is the ordinary anemometric record of the wind at such elevations as this (47 meters) above the earth's surface, where it is free from the immediate vicinity of disturbing irregularities, and where it is popularly supposed to move with occasional variation in direction, as the weathercock indeed indicates, but with such nearly uniform movement that its rate of advance is, during any such brief time as two or three minutes, under ordinary circumstances, approximately uniform. This then may be called the "wind," that is, the conventional "wind" of treatises upon aerodynamics, where its aspect as a practically continuous flow is alone considered. When, however, we turn to the record made with the specially light anemometer, at every second, of this same wind, we find an entirely different state of things. The wind starting with the velocity of 23 miles an hour, at 12 hours, 10 minutes, 18 seconds, rose within 10 seconds to a velocity of 33 miles an hour, and within 10 seconds more fell to its initial speed. It then arose within 30 seconds to a velocity of 36 miles an hour, and so on, with alternate risings and fallings, at one time actually stopping; and, as the reader may easily observe, passing through 18 notable maxima and as many notable minima, the average interval from a maximum to minimum being a little over 10 seconds, and the average change of velocity in this time being about 10 miles an hour. In the lower left hand corner of Fig. 3 is given a conventional representation of these fluctuations in which this average period and amplitude is used as a type. The above are facts, the counterpart of which may be noted by any one adopting the means the writer has employed. It is hardly necessary to observe that almost innumerable minor maxima and minima presented themselves, which the drawing cannot depict.

In order to insure clearness of perception, the reader will bear in mind the diagram does not represent the velocities which obtained coincidently, along the length of two miles of wind represented, nor the changes in velocity experienced by a single moving particle during the interval; but that it is a picture of the velocities which were in this wind at the successive instants of its passing the fixed anemometer, which velocities, indeed, were probably nearly the same for a few seconds before and after registry, but which incessantly passed into—and were replaced by—others, in a continuous flow of change. But although the observations do not show the actual changes of velocity which any given particle experiences in any assigned interval, these fluctuations cannot be materially different in character from those which are observed at a fixed point, and are shown in the diagram. It may perhaps still further aid us in fixing our ideas to consider two material particles as starting at the same time over this two mile course; the one moving with the uniform velocity of 22·6 miles an hour (33 feet per second), which is the average velocity of the wind as observed for the interval between 12 hours, 10 minutes, 18 seconds and 12 hours, 13 minutes, 45 seconds on February 4; the other during the same interval, having the continuously changing velocities actually indicated by the light anemometer as shown on Fig. 3. Their positions at any time may, if desired, be conveniently represented in a diagram where the abscissa of any point represents the elapsed time in seconds, and the ordinates show the distance in feet, of the material particle from the starting point. The path of the first particle will thus be represented by a straight line, while the path of the second particle will be an irregularly curved line, at one time above, and at another time below the mean straight line just described, but terminating in coincidence with it at the end of the interval. If now all the particles in two miles of wind were simultaneously accelerated and retarded in the same way as this second particle, that is, if the wind were an inelastic fluid, and moved like a solid cylinder, the velocities recorded by the anemometer would be identical with those that obtained along the whole region specified. But the actual circumstance must evidently be far different from this, since the air is an elastic and nearly perfect fluid, subject to condensation and rarefaction. Hence the successive velocities of any given particle (which are in reality the resultant of incessant changes in all directions) must be conceived as evanescent, taking on something like the sequence recorded by these curves, a very brief time before this air reached the anemometer, and losing it as soon after.

It has not been my purpose in this paper to enter upon any inquiry as to the cause of this non-homogeneity of the wind. The irregularities of the surface topography (including buildings, and every other surface obstruction) are commonly adduced as a sufficient explanation of the chief irregularities of the surface wind; yet I believe that at a considerable distance above the earth's surface (*e. g.* one mile) the wind may not even be approximately homogeneous, nor have an even flow; for while, if we consider air as an absolutely elastic and frictionless fluid, any motion impressed upon it would be preserved forever, and the actual irregularities of the wind would be the results of changes made at any past time, however remote; so long as we admit that the wind, without being absolutely elastic and frictionless, is nearly so, it seems to me that we may consider that the incessant alternations which it here appears make the "wind" are due to past impulses and changes which are preserved in it, and which die away with very considerable slowness. If this be the case, it is less difficult to see how even in the upper air, and at every altitude, we might expect to find local variations or pulsations, not unlike those which we certainly observe at minor altitudes above the ground.*

(To be continued.)

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* It will be noticed that the fact of observation here is not so much the movement of currents, such as the writer has since learned was suggested by Lord Rayleigh so long ago as 1883, still less of the movement of distinct currents at a considerable distance above the earth's surface, but of what must be rather called the effect of the irregularities and pulsations of any ordinary wind, within the immediate field of examination, however narrow.

See the instructive article by Lord Rayleigh in *Nature*, April 5, 1883. Lord Rayleigh remarks that continued soaring implies "(1) that the course is not horizontal, (2) that the wind is not horizontal, or (3) that the wind is not uniform." "It is probable," he says, "that the truth is usually represented by (1) or (2); but the question I wish to raise is whether the cause suggested by (3) may not sometimes come into operation."

* An example of a very rapid change may be seen on Fig. 4, at 12:23 P. M.

† Here we may note the error of the common assumption that the ordinary anemometer, however heavy, will, if frictionless, correctly measure the velocity of the wind, for the existence of "vis inertiæ," it is now seen, is not indifferent, but plays a most important part where the velocity suffers such great and frequent changes as we here see it does, and where the rate at which this inertia is overcome, and this velocity changed, is plainly a function of the density of the fluid, which density we also see reason to suppose itself varies incessantly, and with great rapidity. Though it is probable that no form of barometer in use does justice to the degree of change of this density, owing to this rapidity, we cannot, nevertheless, suppose it to exceed certain limits, and we may trust the general records, made with an anemometer of such exceptional light [illegible] comparatively unaffected by these changes in density, though

* In this connection, reference may be made to the notable investigations of Helmholtz, on Atmospheric Movements, *Sitzungsberichte*, Berlin, 1888-1889.

THE TEMPERATURE OF IGNITION OF EXPLOSIVE GASEOUS MIXTURES.

By A. E. TUTTON.

An important contribution to our knowledge of this subject is communicated to the *Berichte* by Prof. Victor Meyer, of Heidelberg, in conjunction with his assistant, Herr A. Munch. The interesting experiments which were carried out some eighteen months ago in the Heidelberg laboratory, concerning the conditions under which the explosion or silent combination of gaseous mixtures occurs, left the question of the precise temperatures of explosive combination undetermined, inasmuch as the necessary high temperatures were attained by the use of boiling salts whose temperatures of ebullition lay a considerable number of degrees apart. The researches have since been continued under conditions in which it has been found possible to determine the actual temperatures with precision. In these experiments any possibility of the occurrence of appreciable amounts of silent combination has been avoided, in order that the determinations of the temperature of explosive combination might be unaffected by errors due to that cause. The conspicuous novelty of the method adopted consists in placing the small bulb containing the mixture to be exploded inside the larger bulb of the air thermometer employed to determine the temperature, thus at once insuring that the explosion bulb and the thermometer bulb shall be heated to precisely the same temperature. The objection which at first suggests itself, that the heat suddenly developed at the moment of explosion might exert a disturbing influence upon the indications of the air thermometer, was proved by direct and repeated experiment to be without validity, such disturbance being found to be too small to be measured. The bulb in which the explosion is brought about is not closed, for the explosion of such detonating mixture of gases at rest, that is to say, confined to a closed space, is so violent that if the glass escapes

pulverization it is much distorted, owing to the temperature to which it requires to be heated being about its softening point. The distortion usually takes the form of a shrinking from two opposite points, where the glass is drawn in and distended to such an extent as to produce two internal spheres. Such deformation would of course alter considerably the volume of the air thermometer. This is avoided by attaching a long stem to the bulb, open at the free extremity, and of passing a slow current of the gaseous mixture through the apparatus. The bulb of the thermometer was heated by means of a bath of a fused alloy consisting of equal parts of tin and lead, and it was found immaterial whether the thermometer was directly immersed in the molten metal or protected by means of a closely fitting refractory metal sheath. The estimation of the temperature was effected by displacing the air of the thermometer, whose volume was known, by means of a current of hydrochloric acid gas, and measuring its volume over distilled water which had recently been freed from air by boiling.

The first series of experiments were made with the detonating electrolytic mixture of hydrogen and oxygen. The gases were freed from ozone by passage through a solution of potassium iodide. They were then washed through water, with which a Woulfe's bottle was almost filled, after which they traversed a tube packed with numerous disks of brass gauze, which were found effectual in preventing the explosion from traveling back to the Woulfe's bottle. The mixed gases were then allowed to enter the explosion bulb by means of a capillary tube passing down the stem to the bottom of the bulb. The rapidity of the gaseous stream was found to exert no influence upon the temperature of explosion, within the limits imposed by the mode of experimenting. The bath was then gradually raised to the neighborhood of the combining temperature, and the instant the explosion ensued the air contained in the thermometer was displaced by hydrogen chloride, collected over water in the measuring vessel, and its volume ascertained on the attainment of atmospheric temperature and pressure. By displacing the air the instant the detonation was heard, any appreciable augmentation of the temperature during the moment of explosion was prevented.

As the result of several series of experiments carried out with four distinct sets of apparatus, the temperature of explosion of electrolytic hydrogen and oxygen is found to vary from 612° to 686°. It would thus appear, conformable with the supposition of Prof. Van t'Hoff from theoretical considerations, that this mixture is incapable of exhibiting a sharply fixed temperature of explosion. Moreover, it makes no difference whether the mixture is dry or moist; for if dried a small amount of silent combination invariably renders it again moist before explosion occurs.

It has been currently supposed that the presence of sharp solid fragments, such as those of glass, exerts a lowering effect upon the temperature of explosion of hydrogen and oxygen. This supposition has been practically tested and found wanting in accuracy. Neither glass fragments nor sea sand was found to reduce the temperature below the limits above stated. A remarkable result, however, was obtained when pieces of platinum foil and wire were introduced into the explosion bulb. It was found impossible in their presence to bring about an explosion, even when the temperature of the bath was raised to 715°. Quiet combination invariably ensued.

The size of the explosion vessel appears to be immaterial, except when reduced to very small dimensions, such as 4·5 mm. diameter, as in the case of the smallest bulb tested, when the range of molecular forces is approached. In six experiments with this small bulb no explosion occurred; in others the explosion did not occur in the vessel, but the quiet combustion there initiated was transmitted along the leading tube, through the tube containing the brass gauze disks, and eventually occasioned an explosion in the wash bottle, disastrous to the latter.

In the cases of other explosive mixtures the admixture was effected, in the proper proportion, in a three liter flask, from which the gases were driven first through a wash bottle, and subsequently through a test tube, arranged likewise as a small safety wash bottle, to prevent the explosion reaching the larger one.

Carbon monoxide and oxygen, in the proportion to form carbon dioxide, were found to suffer, for the most part, silent combination in the apparatus, and the wide limits of the observed temperatures of explosion, 636° to 814°, in those cases when explosion did ensue, were found to be due to more or less of such silent combination.

Gaseous mixtures of hydrocarbons and oxygen were found, however, with the exception perhaps of marsh gas and oxygen, to exhibit practically no quiet combination; and these mixtures have afforded most trustworthy and constant temperatures of explosion.

Marsh gas was found to explode, as a rule, with oxygen at temperatures varying from 656° to 678°, but occasionally quiet and complete combustion occurred. Other hydrocarbons never failed to yield an explosion.

Ethane detonated with oxygen in three experiments at 632°, 605°, and 622° respectively. A mixture of ethylene and oxygen exploded at 577°, 590°, and 577° in three consecutive experiments. Acetylene prepared by Gattermann's method, which in Prof. Meyer's experience yields it in a purer state than the more recent convenient method discovered by Maquenne, explodes with oxygen with exceptional violence, the wash bottle being destroyed in every experiment. The temperature of this explosion was very constant, 510°, 515°, and 509° being successively observed. Propane mixed with five times its volume of oxygen likewise exhibits a very constant temperature of ignition, 548°, 545°, and 548° being indicated in three determinations. Propylene exploded with four and a half times its volume of oxygen at 497°, 511°, and 499°. Isobutane mixed with six and a half times its volume of oxygen detonated at 549°, 550°, and 545°; and isobutylene at 546°, 548°, and 537°. Finally, coal gas mixed with thrice its volume of oxygen was found to explode in three experiments at the remarkably constant temperatures of 649°, 647°, and 647°. It was found impossible, however, to induce a mixture of coal gas and air to explode under these experimental conditions.

It will be clearly seen from the above experiments with gaseous mixtures of hydrocarbon and oxygen that the temperature of explosion falls as the content of carbon increases. Thus the mean temperatures for methane, ethane and propane are 667°, 616°, and 547° respectively. Further, the temperature also falls with the degree of saturation, or in other words, the less saturated the hydrocarbons become, the more readily do they ignite in contact with oxygen. Thus ethane, ethylene and acetylene explode with oxygen at 616°, 580° and 511°; propane and propylene at 547° and 504; and isobutane and isobutylene at 548° and 543°. It will also be observed, however, as would be expected, that these differences due to difference of saturation diminish as the series are ascended.—*Nature.*

[Continued from SUPPLEMENT, No. 945, page 15105.]

ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

Lecture IV.†

THE object of this lecture is to afford a guide to the metal work in the art collections in the South Kensington Museum, which are singularly rich in examples of special interest from a metallurgical point of view, and it is in this aspect alone that I can claim any authority in considering them.

The subject with which I have to deal is the "materials used for art metal work," but as they are treated from the point of view of the collections at South Kensington, it will be well to state some historical facts which might otherwise be omitted.

The range of metals and alloys at the disposal of the craftsman is really very wide, but he nevertheless restricts his efforts within narrow limits, and employs but few materials. The pure metals are seldom used, and have hardly any applications in art industries except when in union with other metals. A notable exception is, however, presented by wrought iron work, which I do not propose to deal with, as it has already been admirably treated by Mr. Starkie Gardner. It may be sufficient to point out that the purer the iron is, the better suited it will be for hammering and twisting into delicate shapes, while the presence of some $\frac{1}{2}$ per cent. of carbon, which does not impair its ductility, sensibly increases its durability and rigidity. Even gold is almost always employed with more or less alloying metal added to it, and the alloys of gold have, as I shall subsequently show, a very wide range of tint. Silver, also, is seldom used unalloyed.

The two series of alloys which have prominence in the history of art metal work are those of copper and tin, the bronzes, and the copper-zinc series, the brasses. Next in importance would come the lead-tin alloys, the petwers. Of the alloys of the precious metals, the gold-copper, the gold-silver, and the silver-copper are the most important.

A very beautiful modern chalice, destined for use in the church of St. Martin, Wonersh, was shown as a good example of art work in pewter.

It may be well to take the bronzes first, and the important question at once suggests itself, Was copper employed before the general adoption of the alloy of copper and tin in industrial art? It is well known that the word copper is derived from Cyprus, famed for its copper, the island being under the special patronage of Venus, to whom copper was ultimately, though not, I think, at first, dedicated.

Berthelot has given us the analysis‡ of a little Chaldean statuette of a god, now in the Louvre, which is considered to date from 4000 B. C., and it proved to be of metallic copper. There is also an analysis by Berthelot§ of the scepter of the King Pepi I., a king of the sixth Egyptian dynasty. This scepter, a cylinder 12 centimeters long, covered with hieroglyphics, is in our own British Museum, and its date is believed to be some 3500 to 4000 years B. C. It is of pure copper, probably derived from the mines in Mount Sinai, which are known to have been worked by the Egyptians in the third dynasty.

From the standpoint of anthropology, however, copper plays an essentially different part in prehistoric culture now from what was assigned to it but a short time ago. Whereas it had been assumed that in Europe copper periods existed only in certain localities, Hungary, Ireland, and Spain finds of copper have recently increased to such an extraordinary extent that the assumption of a special copper age, which was in point of time prior to the bronze age, and contemporary with the later stone age, seems to archæologists now inevitable.‖

I cannot enter here into the discussion of the first appearance of bronze. I was inclined to accept the evidence which attributes the name bronze to Brundusium, for it seems clear that just as Cyprus was celebrated for its copper, Brundusium was famous for its manufacture of bronze, especially of mirrors, but my friend Sir George Birdwood sends me the following statement bearing upon the question:

"I cannot find any connection between bronze and Brundusium. This first came into notice only in the third century B. C., and apparently long before the Italian word, *bronzo*, was formed, all memory of any trade in bronze through Brundusium had been lost. The word appears in its English form first in the sixteenth century, and evidently from the Italian; and the Italian *bronzo* is said to mean, originally, 'live coal'—and in reference to their alloy, points to its mode of preparation by burning. Brunette is the same word, and brown and burnt. The objects about us are many, our words for them very few!"

But with regard to the period of its introduction for industrial use, whatever may be the date of Schliemann's "first prehistoric city," Ilios, many of the objects found in it were certainly of nearly pure copper. Dr. Schliemann asked me to analyze two nails or pins which were exhibited, with the rest of his collection, at South Kensington. These contained respectively:*

I.

Copper	97·83
Tin	0·21
Iron	0·90
Nickel and cobalt	traces.
	98·94

II.

Copper	98·20
Iron	0·75
Sulphur	0·13
Tin	trace.
	99·08

The metal examined was from the center of the pins, and was freed as nearly as might be from the investing layer of carbonates and oxides.

I believe that the presence of tin is entirely accidental. Schliemann concluded, on the evidence supplied by these analyses, that all the objects from the first and second cities of Hissarlik were of copper, and indicated the existence of a pre-bronze age, and even if the date of these copper articles be no older than 1500 B. C., their occurrence is very useful in enabling the period at which tin was alloyed with copper to be defined, even roughly, for in the layer of deposits which Schliemann calls the third city, and identifies with Homer's Troy (about 1200 B. C), the articles I analyzed were undoubtedly of bronze. M. Damour, of Lyons, also analyzed some of the battle axes from this third city and found them to contain:

I.

Copper	95·80
Tin	3·84
	99·64

II.

Copper	90·67
Tin	8·64
	99·31

I found in other portions of the same axes:

III.

Copper	93·80
Tin	5·70
	99·50

IV.

Copper	95·41
Tin	4·39
	99·80

Sir George Birdwood tells me that for a thousand years before 1200 B. C. the Phœnicians had been actively trading in the Levant, and their commerce was at its height 1500 B. C.

Our knowledge as to the first appearance of bronze has, however, received recently a somewhat astonishing piece of evidence. Dr. Flinders Petrie has found a rod of metal, which is believed—from the position in which it was found at Meydum—to date from the IVth Dynasty, about B. C. 3700. This rod was analyzed by Dr. Gladstone,† who finds that it contains:

Copper	89·8
Tin	9·1
Arsenic	0·5
Antimony, Iron, Sulphur	traces.
	99·4

So that we have here a specimen of bronze of 3700 B. C. which has about the ratio of nine copper to one tin, characteristic of far later and even of modern bronzes.

Further evidence as to the composition of ancient bronze is, however, forthcoming. At the request of Sir John Donnelly, Secretary of the Science and Art Department, analyses were recently made,‡ under my direction, of certain objects in our own South Kensington collections, and a few antique bronzes in the British Museum. These analyses were made by Mr. A. Wingham, a chemist of great skill, and are absolutely trustworthy. Of the objects selected, probably the oldest is No. 82, and the next is No. 79. It is important to remember that the Etruscans were not dependent for tin solely on imports.

No. 79.—Bronze Figure of a Lion. Etruscan work. Fifth century B.C. '73. 8-20. 251.

Analysis.

Copper	82·10
Tin	12·64
Lead	1·86
Zinc	0·73
Iron	trace.
	97·33

No. 82.—Fragment of Drapery found with leg of bronze statue. Greek sculpture. About B. C. 450. '86. 3-24. 7*a*.

Analysis.

Copper	84·49
Tin	9·47
Lead	5·31
Iron	trace.
	99·27

There is, therefore, a clear case for the introduction of tin in Etruscan and Greek work in the fifth century before Christ. The presence of zinc is probably accidental.

But now we must consider the important point con-

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† Some of the particulars contained in this lecture were given in a lecture delivered at South Kensington Museum in 1882, and some portions, relating to Japanese art metal work, formed the subject of a paper read before the Applied Art Section of this Society, which appeared in the *Journal* June 30, 1890.

‡ "Ann. de Chim. et de Phys.," xii., 1887, p. 131.

§ "Ann. Chim. et de Phys.," xvii., 1889, p. 507.

‖ "Prehistoric Antiquities of the Aryan Peoples." Schrader and Jevons edition, p. 191.

* Ilios, 1880, p. 251.

† "Proc. Soc. Biblical Archæology," March, 1893.

‡ The numbers given over each analysis refer to the "Report on the Analyses of various examples of Oriental Art Metal Work in the South Kensington Museum, and other Collections," made under the direction of the author of this lecture by Mr. Arthur Wingham, 1892. Price 6d. It may be purchased at the South Kensington Museum.

nected with the occurrence of lead and zinc. An eminent and careful authority, Dr. C. Drury Fortnum,* leans to the view that the presence of lead in bronze, indicated by Pliny, was due to the addition of the metal as an adulterant of the tin, and with a view to increase the fusibility of the alloy. No doubt tin was adulterated with lead; in fact, Pliny tells us that it was so; but my own opinion is that the fact that the presence of lead enables the bronze both to be more easily fused and, above all, to assume a beautiful velvety brown patina, was recognized far earlier than has been supposed, and this supposition is sustained by the occurrence of lead in analysis No. 82 of the fragment of the Greek bronze, the date of which is about B. C. 450.

With regard to the presence of lead in large bronze works, the Florentine artists do not seem to have been very particular as to its amount. For instance, the description of the casting of the Perseus in the Loggia di Lanza at Florence is too well known to need repetition, and I will only refer to it to point out that, if Cellini's boastful account of the casting is true, there must be far more lead in it than the artist intended, for he says that, finding the metal was setting in the furnace before he had time to transfer it to the mould, he ordered all his pewter dishes and porringers, which were in number about 200, to be placed before the ducts through which the bronze had to run, and presently the bronze became fluid again, and the casting successfully accomplished.

Now, with regard to the presence of zinc, Pliny describes in much detail the various shades of color presented by bronze, and it is of interest to fix the date, or at least the period, at which zinc was deliberately introduced, in view of the very important part played by zinc either as affecting the natural tint of the tin-copper alloys or as influencing the color of the patina produced by atmospheric action. In order to effect the introduction of zinc into bronze, it was only necessary to add zinc ores to the furnace charge; the metallic zinc became reduced from the ore and passed into the alloy. I have elsewhere expressed the view that brass, which was common enough in Roman time, was not much used in this country until my namesake, William Austen, in 1460, made the magnificent monument in brass which covers the greatness of Richard Beauchamp, Earl of Warwick.

No. 9.—Astrolabe? Brass engraved. It appears to have been gilt, and is slightly inlaid with silver. It bears the date of the Hegira 598 (A. D. 1202), and was made at Damascus by Abdul Rahman, son of Iusuf. *Persian* or *Saracenic.* 9¾ in. by 8 in. 504. '88.

Analysis.

Copper	79·40
Arsenic	0·157
Antimony	nil.
Tin	1·125
Lead	2·145
Bismuth	trace.
Iron	0·350
Nickel	trace.
Zinc, by diff	16 823
Silver	trace.
Gold	nil.
	100·000

No. 4.—Candlestick. Brass, inlaid with silver, and engraved with Arabic inscriptions recording Memluk titles of the 14th century round base and neck and on other parts, divided by medallions of geometrical designs and by rosettes of flowers. *Saracenic.* 14th century. H. 10 in., diam. 9 in. 4505. '58.

Analysis.

Copper	84·75
Arsenic	trace.
Antimony	nil.
Tin	2·360
Lead	0·656
Bismuth	trace.
Iron	0·098
Nickel	trace.
Zinc, by diff	12·084
Silver	0·052
Gold	nil.
	100·000

No. 7.—Mortar. Brass, octagonal, chased with arabesques and Kufic inscriptions. Round the sides are projecting knobs, and on one side is a ring suspended from a bull's head. Found in the ruins of the city of Rhages. *Persian.* 10th or 11th century. H. 5¼ in., diam. 7 in. 466. '67.

Analysis.

Copper	68·19
Arsenic	trace.
Antimony	nil.
Tin	3·827
Lead	14·990
Bismuth	trace.
Iron	0 448
Nickel	trace.
Zinc, by diff	12·963
Silver	0·082
Gold	nil.
	100·000

No. 40.—Vase, with handle and cover. *Phuldan.* Perforated brass; the cover surmounted by a knob; the handle formed by two dragons. *Nepal.* H. 11⅛ in., diam. 7⅛ in. 89. (I.S.) 1886.

Analysis.

Copper	78·58
Arsenic	trace.
Antimony	2·037
Tin	0 236
Lead	2·721
Bismuth	0·070
Iron	0·140
Nickel and cobalt	0·068
Zinc	15·849
	99·701

* "A descriptive catalogue of the bronzes in the South Kensington Museum, 1876. Introduction."

No. 53.—Gun. Analyses of two samples, the first from the mouth end, the other from the tail or breech end. Lent by H.R.H. Prince of Wales. Length, 9 ft. 3 in.; bore, 3¼ in.

Copper	89·49
Arsenic	trace.
Antimony	trace.
Tin	4·893
Lead	2·118
Bismuth	trace.
Iron	0·238
Nickel	trace.
Zinc	3·049
Gold	nil.
Silver	nil.
	99·788
Copper	85·93
Arsenic	trace.
Antimony	trace.
Tin	7·654
Lead	4·748
Bismuth	trace.
Iron	0·210
Nickel	trace.
Zinc	1·501
Gold	nil.
Silver	nil.
	100·043

No. 51.—Bell, with dragons in relief, and incised inscription. Burma. 05,219.

Analysis.

Copper	78·12
Arsenic	0·221
Antimony	nil.
Tin	19·18
Lead	1·913
Bismuth	0·097
Iron	0·105
Nickel	0·114
Zinc	nil.
Silver	0·090
Gold	nil.
	99·840

The bell contained on its outer surface a long inscription, of which the following is part (translation):

"We two, brother and sister, have given this bell as an offering to the seven Precious Things. In this attempt to merit Neh'ban, our arrangement was as follows: We took our own weight in gold, and in silver and bright copper and other metal (Laukad, the Pali word used, implies five metals—gold, silver, copper, iron, lead), and mixed them well together. In the year 1209 (1847 A. D.), in the hot season, at a fortunate hour, I had moulded it, setting my heart on giving it in alms.

"As I wrote the inscription I offered up abundant prayer that no enemies or troubles might come nigh me, and that I might attain Neh'ban.

"Then I dedicated it."

The next analyses are similar to the above.

No. 52.—Bell, bronze. Swinging shackle ornamented with two grotesque lions. With inscription, dated 1828 A. D. *Burmese.* H. 3 ft. 4 in., diam. 2 ft. 2 in. Presented by Commander C. McLaughlin, R.N. 76. (I.S.) 1884.

Analyses of Two Samples, the first taken from the Lip, the other from the Top.

Copper	78·50
Arsenic	0·205
Antimony	0·198
Tin	12·73
Lead	5·520
Bismuth	0·215
Iron	0·322
Nickel	trace.
Zinc	1·749
Silver	0·263
Gold	nil.
	90·702
Copper	78·05
Arsenic	0·154
Antimony	0·229
Tin	12·85
Lead	6·292
Bismuth	0·251
Iron	0·210
Nickel	trace.
Zinc	1·524
Silver	2·18
Gold	nil.
	99·778

No. 60.—Bronze Tortoise, Modern Japanese.

Analysis.

Copper	81·62
Tin	4·61
Lead	10·21
Iron	0·22
Zinc	2·42
	99·08

This sample, from a specimen in my own collection, was a very good and well defined casting, moderately hard and brittle.

Of all the bronze castings I have seen, two stand out in memory as being specially impressive, one of these is 17th century Italian work, and the other modern Japanese. The former of these is the large statue in the magnificent Medici chapel of the Church of St. Lorenzo, Florence, of Ferdinand III. (1609), modeled by Gian da Bologna, and cast by Pietro Tacca. Bologna's character must have presented a marked contrast to that of Cellini, for contemporary accounts represent him as being "honest, disinterested, industrious, obliging, and agreeable to all."* The statue is composed of different colored bronzes, probably lightly gilt in parts, and the texture of the brocaded robes is wonderfully rendered, as in the fur cape. The statue in a second niche of Cosimo IV. (1620) was entirely by Pietro Tacca. The tints of the bronze are quite fresh, and can hardly have been impaired by age.

(*To be continued.*)

* "Florence," by C. Yriarte. Paris, 1881.

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